DISCOVERY

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The Progress of Science

A MONTHLY NOTEBOOK COMPILED UNDER THE DIRECTION OF DAVID S. EVANS

Immunisation and Democracy

As a result of the campaign by the Ministry of Health for the immunisation of the children of Britain against diphtheria, some 3,750,000 of Britain's 8,250,000 children under fifteen had been immunised by the end of 1942. Thus just over 45% of the children have been given an added degree of protection against this killing disease. The extent of that protection may be judged from the fact that in the two and a half years from the beginning of 1940 to the end of June, 1942, there were over 81,000 cases of diphtheria, of which only 5,235 were among immunised children. The latest figures show that the effect of immunisation is to reduce the incidence of the disease over the whole country from 5,400 per 1,000,000 for non-immunised children in 1942 to 959 per 1,000,000 for immunised children in the same period. The effect on the death rate is even more striking, for the mortality figures for 1942 are 321 per 1,000,000 for non-immunised children, and only 11 per 1,000,000 for immunised children. The figures for particular counties are even more impressive and some show a zero death rate for immunised children. It is clear that immunisation has been immensely successful, and that it can go a long way towards wiping out diphtheria from this country. On the basis of the above figures it reduces the chance of your child contracting diphtheria fivefold, and its chance of death from the disease thirty fold.

It is therefore with considerable surprise that we have seen recently in various parts of the country large posters whose legend runs as above.

DOES IMMUNISATION PROTECT?

The Minister of Health stated on December 17th, 1942, in reply to a question in the House of Commons, that the number of cases of

DIPHTHERIA IN IMMUNISED CHILDREN

in England and Wales, recorded from January 1st, 1940, to June 30th, 1942, was approximately—

5,000

Further information from the Secretary, British Union for the Abolition of Vivisection, 138, Widemarsh Street, Hereford.

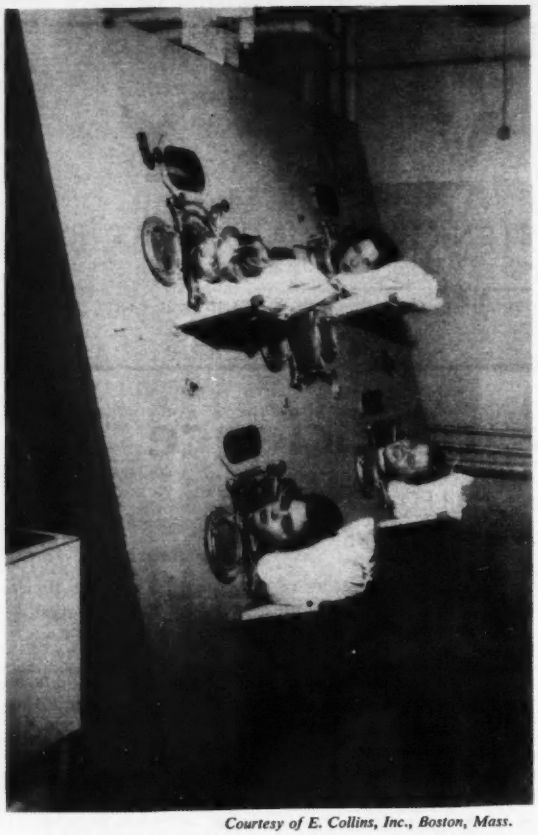
The Poster in Question

The widespread nature of these posters indicates that a considerable sum has been expended on this propaganda, and it is of interest to speculate on the origins and objects of this campaign.

It can hardly be supposed that the question at the head of the poster indicates a genuine desire for further information on immunisation; indeed the Secretary of the Union states that he is prepared to supply it. Presumably the reply to further enquiry would be that in fact immunisation gives at least 97% protection against death from diphtheria in children. But while it might be claimed that the Union was actuated only by an honest desire to give further information in support of immunisation to those who were prepared to take the trouble to write a letter of enquiry, it is clear that the effect of the poster on the general public is to produce an effect exactly opposite to this.

The choice of a period of two and a half years for the reckoning of the death rate produces in the end a figure, which, to the inexperienced, seems very large, and will therefore have the effect of discouraging parents from taking advantage of the facilities for immunisation provided by the authorities. The Union would therefore do well, if its desire is to support the immunisation campaign, to supply the comparative figures, which would demonstrate immediately the value of immunisation, and enable even the layman to form an objective judgment on the matter.

That the Union wishes to aid the immunisation campaign is the charitable explanation, since the publication of such a poster with intent to frustrate the campaign would argue a logic warped almost beyond belief, and



Courtesy of E. Collins, Inc., Boston, Mass.

FIG. 1.—Exterior view of the respirator room at the Children's Hospital at Boston, Mass. This arrangement enables the treatment of as many as four patients to be supervised by only one or two nurses.

actuated by motives of the most suspicious kind. Anyone in full possession of the facts who advocated the cessation of the immunisation campaign must realise that if such advocacy met with success, then there would be, on the basis of the figures given above, approximately 20,000 avoidable cases of diphtheria in the coming year, and about 1440 avoidable deaths. No one who advocates a particular course of action can reasonably be said to be exempt from the responsibility of the consequences which such a course of action would entail. If therefore any body of persons were, while in possession of the full facts, to advocate the cessation of the immunisation campaign, then they would be either criminally irresponsible or genuinely desirous of the death roll which the cessation of that campaign would entail. In a parallel case, the advocacy of a course of action which would patently lead to the avoidable deaths of 1440 soldiers or workers would be given a much more sinister and ignominious label.

We must assume then that those responsible for the publication of these posters must have been actuated by the higher principle of affording to the public further information in support of the immunisation campaign, since the alternatives are either that they are ignorant of the facts, or actuated by motives of the kind sketched above. Indeed, this must be the explanation, if for no other reason than that the logical path from the advocacy of the abolition of vivisection—even under the mistaken impression that it causes unnecessary suffering to animals—to the advocacy of a course of action which would involve suffering and death for thousands of children, is so tortuous that it could hardly be followed by any human being capable of the most rudimentary reasoning.

No, we must conclude that the Union desires to promote diphtheria immunisation, and can only regret that this laudable object is unlikely to be achieved by the particular type of propaganda which has been selected. Unfortunately—however high the motives behind it—it can only have the effect of impeding the progress of a campaign which the Ministry is conducting in the public interest. It may be enquired whether it is not an extravagant extension of the principles of democracy to allow the publication of such material, and the expenditure at this time of labour and materials upon it. In this particular case the motives, as we have seen, must be above reproach. The effect is nevertheless deplorable, and it would be a service to the community if representations were made to the Union that their propaganda was not serving the intended effect. Furthermore, if this action was not successful, steps should be taken to see that the Ministry is not embarrassed by the efforts of less-experienced allies in its promotion of the immunisation campaign.

Iron Lungs

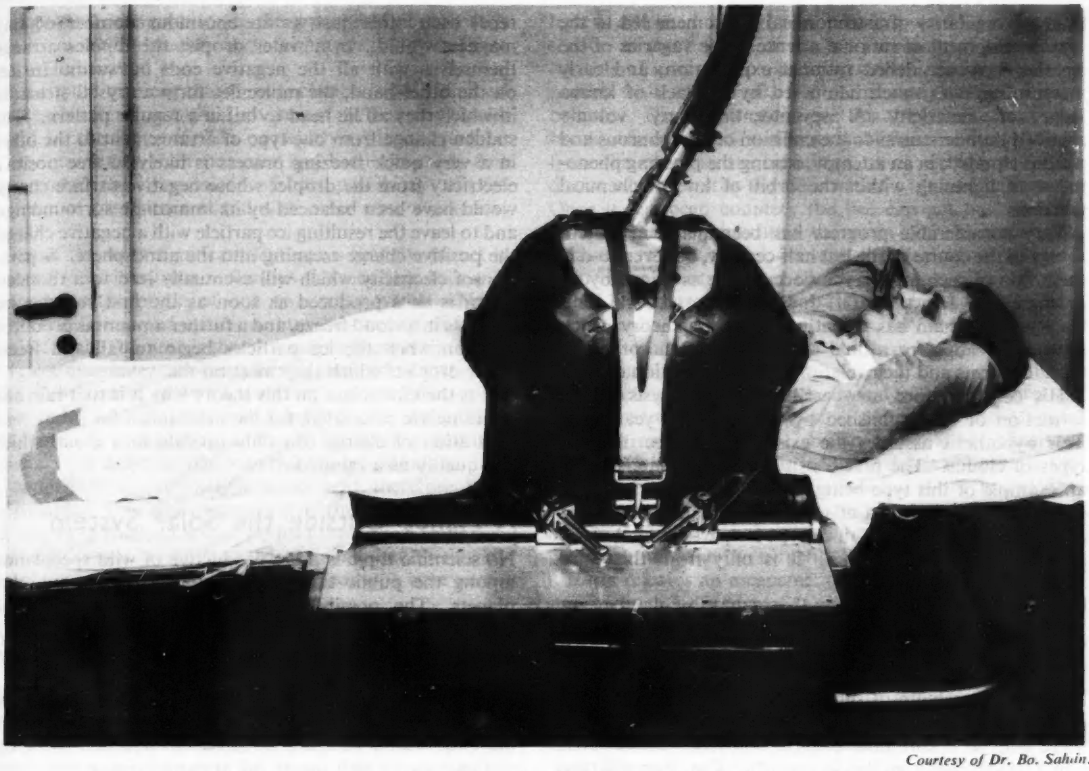
CONSIDERABLE newspaper publicity has been accorded to the device known as the "iron lung", and it is of interest to give some details of the principle on which it works, and its medical applications.

The iron lung is a device for maintaining the breathing of those whose breathing muscles have become paralysed. This arises usually as the result of an attack of infantile paralysis or poliomyelitis, a disease which usually attacks young or pre-adolescent children, but sometimes occurs in adults as well. The disease is due to a virus infection, that is to an ultra-microscopic type of organism of the kind which has recently been studied by the electron microscope. It is thought that the disease may be spread by droplet infection from the moisture in the breath of an infected person. It is thus one of the diseases against which we are warned by the Ministry of Health, which are spread by "coughs and sneezes", and it is one of the reasons for "using your handkerchief".

This particular disease is believed to be spread into the brain from the mouth and nose along the nerves responsible for the sense of smell. Once in the brain the virus is liable to attack the brain centres responsible for various bodily functions, and by putting the nerves out of action to paralyse the muscles controlled by those nerves.

Sometimes the nerves controlling the muscles responsible for breathing are put out of action, and the sufferer would then suffocate if he were not given some artificial aid to breathing until his nerves have recovered and can take on the job once more.

Since recovery may take several months, ordinary artificial respiration is impossible, and a simple mechanical device is used. The patient is placed in a closed metal cylinder, with his head protruding from one end. The pressure in the cylinder is regularly raised and lowered mechanically. When the pressure is low the chest wall is



Courtesy of Dr. Bo. Sahlin.

FIG. 2.—A modified type of iron lung invented by a Swedish doctor, which is often more convenient than the conventional type.

pulled outwards, the lungs are expanded, and the patient breathes in. Then the pressure in the metal "lung" is increased, the chest wall and the patient's lungs are compressed, and he or she is forced to breathe out.

The iron lung has been associated with a number of sensational stories and not the least of these is concerned with the case of Frederick Snite (Jr.), the twenty-five-year-old son of an American millionaire, who was stricken with infantile paralysis in March 1936 while travelling near Peiping in China. Fortunately for him Peiping possessed the only iron lung in China, and his life was saved. Eventually he was transported at enormous cost back to his home in Chicago. Other cases are on record of the nearest available iron lung being transported to a sufferer, sometimes by aeroplane. A young girl in Texas who contracted the disease was flown to a distant hospital which possessed an iron lung, and later when the citizens of her town had subscribed funds for the provision of an iron lung of their own, she was placed in it, and flown back home while still inside. The aeroplanes in this case were provided by the U.S. Army Air Corps after an appeal had been made to the President, himself a former sufferer from the disease, which did not however attack his respiration.

Recent developments in the United States have been the provision of a multiple respirator at the children's hospital in Boston. Here the chamber in which the pressure is changed is very large, and it has been found possible to conduct surgical operations inside the respirator room while the patient's breathing is being maintained artificially. The effects on the surgeon and nurses inside the room are very slight, and can be eliminated by the wearing of cotton-wool plugs in the ears.

The chief difficulty has always been to have an iron lung available near at hand when the emergency arises, and this has been achieved in this country by Lord Nuffield's gift of numerous iron lungs to our hospitals. The effect has been to make available to everyone the possibility of treatment which would otherwise be restricted to the very wealthy, and is in sympathy with the modern trend for the democratization of medical services. Infantile paralysis is fortunately a comparatively rare disease in this country, and is by no means so important in its social effects as, for instance, diphtheria, tuberculosis, and venereal disease. Medical aid in these diseases is becoming more widely available, but even after the best curative measures are universally available, there will still remain the big problem of abolishing the conditions of poverty and bad housing which do so much to encourage the incidence of disease.

Making Heavy Weather

ANCIENT man was impressed equally by the violent phenomena of the thunderstorm and the gentler phenomena of the movements of the sun, moon and stars. All were explained as the work of a pantheon of gods, but in

time the regularity of astronomical phenomena led to the first development of rational science. The vagaries of the weather however defied rational explanation, and early meteorology was much hampered by the lack of knowledge of electricity. A seventeenth-century volume ascribed thunderstorms to the collision of "sulphurous and nitrous clouds", in an attempt to bring the puzzling phenomena of lightning within the orbit of known chemical reactions.

Very considerable progress has been made in meteorology in the course of the last half-century, but even to-day the origin of such an everyday occurrence as rain is by no means clear. However, Dr. J. R. Chalmers of the University of Durham has recently proposed a theory which gives some hope for a final explanation of the origin of thunderstorms and their relation to the production of rain.

His considerations are based on a hypothesis of the formation of rain published by Bergeron ten years ago. This hypothesis assumes the existence of three different types of clouds. The first consists solely of water drops, an example of this type being fog. Others, such as cirrus clouds, which are found at very high altitudes, consist of ice particles, while in the third type ice particles and water droplets are found together. It is only from this third type that rain can fall.

The co-existence of water and ice in the same cloud means that the water must be supercooled, that is, that the droplets are in an unstable state in which their temperature is actually below freezing-point although they are not frozen. The vapour pressure of supercooled water is greater than that of ice at the same temperature, and this means that there will be a continual evaporation from the droplets and a condensation on the ice crystals. The latter will thus grow bigger and bigger at the expense of the droplets, and will eventually become so heavy that they will start to fall. They melt as they pass through the warmer low strata of the atmosphere, and strike the ground as water drops, usually referred to as rain.

If the rate of condensation on the ice particles is very high, and the cloud comparatively low, the ice particles have no time to melt again, and come down as hail.

It is for these reasons that we never get rain from the very high clouds in our atmosphere, which consist only of ice particles, nor from fog, which consists only of water drops.

An important practical case which furnishes evidence in support of the theory of the formation of ice on the wings of aircraft. The particular mode of formation makes it clear that the ice cannot have condensed from vapour, nor can it be due to the agglomeration of ice particles. It must be due to the freezing of supercooled water droplets striking the wings. The existence of Bergeron's hypothetical water droplets with a temperature well below freezing is thus proved beyond doubt.

The frequent association of rain with thunderstorms makes it clear that the separation of electricity in the atmosphere which eventually leads to its discharge as lightning must be connected with the formation of raindrops.

Dr. Chalmers suggests that this separation is in fact due to a directional property of the molecules of water forming the surface of a droplet.

The water molecules are electric dipoles, which have a positive end and a negative end, and which attract and repel each other just as an enormous number of tiny magnets would. In a water droplet the dipoles arrange themselves with all the negative ends outwards. In ice, on the other hand, the molecules form a crystal structure in which they all lie head to tail in a regular pattern. The sudden change from one type of arrangement to the other in a very quick freezing process is likely to free positive electricity from the droplet whose negative surface charge would have been balanced by its immediate surroundings, and to leave the resulting ice particle with a negative charge, the positive charge escaping into the atmosphere. Separation of electricity which will eventually lead to a thunderstorm is thus produced as soon as the first supercooled droplets in a cloud freeze, and a further amount is produced later on when the ice particles begin to fall and freeze water droplets which they meet on the way.

It is therefore clear on this theory why it is that rain and lightning are associated, for the mechanism for produing a separation of charge can only operate in a cloud which can qualify as a rainmaker.

A Planet Outside the Solar System

No scientific topic is more productive of wild speculation among the public than the possibility of life on other planets. The possibility that other stars may possess planets on a pattern similar to our solar system runs this a good second, and astronomers have almost always adopted an attitude of great reserve towards the possibility.

The stars are all at such an enormous distance that the feeble light reflected from any such planetary bodies which did exist would be quite invisible. In addition the great distance would also shrink the apparent size of the planetary orbit, so that even if it were bright enough to be visible, it would probably appear so near to the parent star that its feebler radiance would be drowned in the general glare.

The only way of deducing the existence of such a body would be indirectly, from the slight perturbation which its gravitational action would produce on the presumably much more massive bright star. Thus a star which had a planetary companion might be expected to betray its presence by a minute and regular variation in its position.

Such a conclusion would need to be supported by very conclusive and extensive evidence, for the expected variations are so minute that they would always lie at the very extreme limit of possible measurement. In addition, astronomers are only too well aware of the sinister tricks which errors can play. Arising from certain types of cause there may be minute and regularly varying errors which simulate all too well some real and regular physical cause.

In spite of all this the work of Dr. K. Aa. Strand on the near star known as 61 Cygni is of very great importance. This star which is an unobtrusive member of the constellation popularly known as the Northern Cross, was the first star whose distance was measured. It is actually a visual binary star, consisting of two components which revolve round one another, and recently Dr. Strand, on the basis of extensive and very accurate observations made by the observatories at Potsdam, and at Sproul and Lick in the U.S.A., has concluded that there are certain irregularities of position which can only be accounted for on the

assumption that in addition to the two visible stars there is a dark, invisible planetary body with a mass sixteen times that of Jupiter.

If it should turn out that this conclusion is well-founded it represents an astronomical advance of the first magnitude. It will be the first occasion on which a planet attached to any star other than our sun has been detected, and will render the discussion of the possibility of the existence of planets associated with other stars a practical issue.

One of the most significant features is that the planet is attached to a binary star. Various theories have been put forward for the origin of our own solar system. None have entirely escaped criticism, but the one which holds the field at the moment is that our solar system is the result of a close encounter between a binary star and an intruding star, in the course of which a certain amount of material was torn by tidal effects from the body of one of the stars, and remained attached to it, finally condensing into the planets. The difficulty has been that the conditions for this to happen were extremely critical, and therefore very improbable. This new discovery may provide support for this theory if it appears that we no longer have to regard our solar system as an isolated accident, but merely as one of the many cases in which the conditions were particularly favourable.

How Many Bees Make Hive?

It is just as important for the scientific beekeeper to know how bees enter and leave the hive at various times of the day, and at different seasons of the year, as it is for the shepherd to know the size of his flock. Indeed this knowledge is important not only for the study of the biology of the bee, but for the proper understanding of such agricultural problems as the pollination of crops. Various attempts have been made in the past to provide an apparatus which will automatically count the entrances and exits of the bees in the hive, but the problem is by no means simple. Recently, however, Dr. A. C. Fabergé of the Rothamsted Experimental Station in Hertfordshire has devised and used such an apparatus with very considerable success.

In order to get a correct estimate of the comings and goings of the bees, their normal habits must be disturbed as little as possible. For instance, for a hive of normal size, it has been found necessary to provide more than a dozen entrance gates, and a similar number of exits—each allowing the passage of one bee at a time—simply to avoid crowding which might interfere with the normal activity of the colony. In addition, a counting device has had to be provided for each one of these gates, since the bees, like humans, show a preference for a particular route, and hence counting at only one or two of the gates would not give a representative sample of the whole hive.

When the bee wishes to leave the hive it has to crawl down a little funnel-shaped tunnel, at the end of which light is admitted through a tiny barred window. The last section of the tunnel, just before the window is reached, consists of a tiny celluloid tube, which is not rigidly connected with the tunnel, but forms one side of a tiny balance. The weight of the bee tips the balance, and this breaks one electric circuit and establishes another. Leads from the contacts are connected to an electric counting device which records the numbers of exits and entrances. Once it has been counted, the bee can get out through another little window into the open air. Flaps at the entrance to the tunnel prevent the bee crawling back inside once it has punched the clock.

The arrangement at the entrance holes is similar to that for the exits and use is made of the tendency for bees to creep into any dark hole on the hive in order to gain admission.

The device which counts the crowd as it passes through the turnstiles is very ingenious. The numbers of entrances and exits may be very large, and hence would be difficult to record as a simple total. In addition this is not exactly the information required. What is needed is the knowledge of the *rates* of entry and exit at different times. This information is provided in the following way. Each time a bee passes out through the turnstile the electric impulse which it starts releases an escapement which moves a tiny metal strip through a distance of 1 millimetre. This strip carries a cross or a circle on its underside, and moves across a roll of paper. From time to time the strip is depressed and prints its symbol on the paper. In order to count the bees, a suitable time interval—perhaps 10 minutes—is chosen, in which the number of entrances will be less than, say, 120. The machine is given an adjustment corresponding to this interval and is set going. In the first ten minutes perhaps only 20 bees will leave, and the metal strip will be shifted across the roller through a distance of 20 mm. At the end of 10 minutes the mechanism prints a circle on the paper roll at 20 mm. above the zero line. The machine immediately resets itself, and starts counting again from zero for the second 10-minute interval. In this way, as the paper unrolls, a series of circles will be printed on the paper at regular intervals, the height of the circles above the zero line indicating the number of bees which have gone out in the previous 10 minutes.

If the number exceeds the capacity of the machine, a special device is included for automatically resetting the machine before the 10 minutes are up so that the record is not lost.

A similar arrangement is provided for counting the entrance rate, and these are recorded as crosses on the same strip.

What the machine records is thus what the statisticians call a "histogram", and a glance at the record will show just how many bees entered or left the hive between, say, 10.0 a.m. and 10.10 a.m. This sort of detailed information is just what scientists need for a full understanding of the way in which the activities of the bee fit into the whole picture of the lives of crop plants.

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Optics and Aviation

J. P. LAWRIE, Ph.D., F.I.G.S.

THE enormous expansion of the air forces of the world lends particular interest to the reports on vision and aviation which have recently been issued by the Tenth International Congress of Military Medicine and Pharmacy, Washington, D.C., at which Air-Commodore H. E. Whittingham represented Gt. Britain. Of recent years Wing-Commander P. C. Livingston has introduced improvements in tests for visual accuracy, among which are the angular depth perception apparatus, whic his a modification of the three-pin test so as to permit rotation of the pins in parallel through a complete circle for the purpose of removing binocular vision when judging distance; it is most difficult to assess the relative position of the pins as regards distance when binocular vision is not in operation, i.e. when the pins are horizontally placed. In addition, the pins (or wires) are made specially fine (1 mm. in diameter) to overcome, as far as possible, the factor of size of objects in the analysis of distance.

Results are recorded graphically as the middle pin is moved by the candidate while endeavouring to judge its position relative to the two fixed outer pins. This instrument is valuable in assessing visual judgment of distance in various optical planes, a factor in vision not necessarily proportionate to visual acuity and ocular muscle balance.

The rotating stereogram was devised by Livingston to ascertain visual conception of depth, and whether or not stimuli are reaching consciousness through both eyes simultaneously—important factors in preparing to land aircraft. The stereoscopic sense can be estimated as a percentage of normality. The apparatus is used with the Holmes stereoscope and consists of a special holder for a pair of stereoscopic pictures, which can be rotated through 180° by means of a centrally-placed cogwheel; this permits of an infinite variation in the stereoscopic values of the pictures. There are ten pairs of pictures, Nos. 1 to 5 to test the stereoscopic sense and macular reception rate and to reveal the presence of any monocular or alternating neglect or suppression, whereas all the pictures which are translucent may be used with the amblyoscope in the orthoptic treatment of ocular muscle unbalances.

The binocular gauge was introduced by Livingston in 1935 as the standard instrument to measure ocular muscle power—convergence, accommodation both binocular and monocular, and the master eye, as good near vision is so important in landing aircraft. The apparatus consists of a wooden rule 36 cm. long, with a slot (21cm. long) cut down the centre and with one end shaped to fit against the upper portion of the face. It is marked in half-centimetres measured from the anterior corneal surface. A vertical rod, 5 cm. in height, with a black central portion and white areas above and below, and with a lateral pointer to mark the scale, slides in the measuring groove to assess convergence—the normal being 6 to 10cm. An ivorine square with letters cut into it is fitted into a box attachment to slide back and forwards to measure accommodation. A black shield at the face end of the apparatus occludes each eye in turn when testing monocular accommodation.

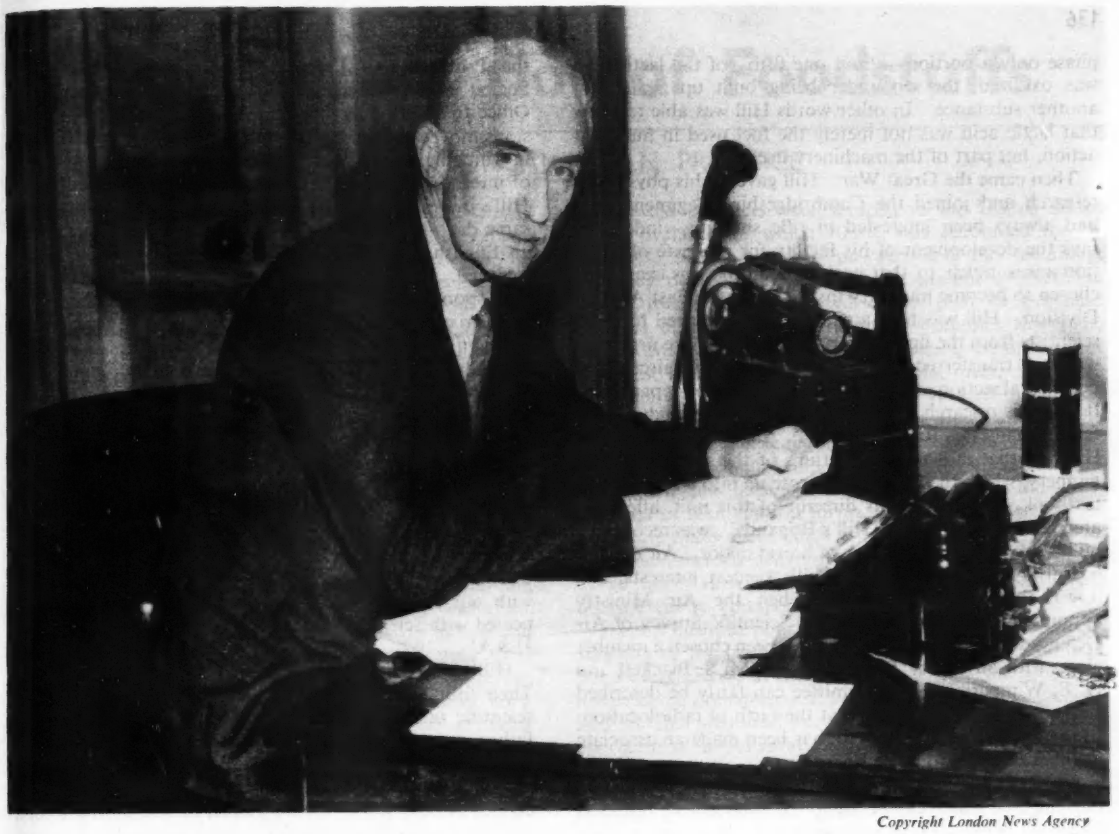
From 1919 to 1934 Group-Captain E. C. Clements investigated the problem of heterophoria as it affects the aviator, with special reference to landing, and he devised means of correcting it and was successful in 90% of cases; Livingston has perfected this eye training, which is of benefit not only to aviators but to golfers and tennis players. Clements and Livingston have materially aided in the design of bomb sights as well as the lighting of cockpits and arrangement of instruments in the instrument panel so as to eliminate, as far as possible, ocular fatigue. In addition, Livingston has studied the effect of sun glare, also the effect on eyes of pilots of flares for night landing, and as a result has developed a highly satisfactory form of flying goggle and spectacle, which practically eliminates glare such as is encountered when flying over cloud and water or towards the sun, and which will give a full field of vision both in front and laterally as well as permitting binocular vision when landing. These goggles have been specially designed to remain fixed to the flying helmet at any speed and to allow of immediate and easy adjustment to any desired position, as well as any width of nose. They are so constructed that triplex glass filters of various tints, appropriate for day or night flying, or suitable lenses for visual correction, can be instantaneously slipped in as required while flying. Moreover, they are provided with a dark visor which can be tilted in position in front of the goggles to enable the pilot to fly, if necessary, directly towards the sun with the minimum of glare effect. Recently, glasses have been made containing spluttered platinum or aluminium which, by their high refractive power materially decrease glare and heat from the sun and at the same time give improved visual definition.

Blacking-out has interested both the opthalmologist and physiologist since it was first encountered by aviators during the period of training for the Schneider Trophy race in 1929, when aeroplanes had developed sufficient speed to produce centrifugal forces greater than 4 "g" while performing sharp turns, whether loop or spiral, at high speed. The main effects are first a feeling of being pressed down in the seat of the aeroplane, then of the abdominal contents being displaced downwards. This is followed quickly by increasing visual dimness, and then sudden blindness or "blacking-out" occurs.

Consciousness is usually retained. The blacking-out period usually lasts two to five seconds and passes off as suddenly as it occurs when the force of the loop or turn becomes less than 4 "g".

From researches carried out mainly in Great Britain it appears that the centrifugal force causes the blood to flow from head to feet, causing increased volume of the lower limbs. Head and heart are drained of much blood and this reduces the blood pressure in the central artery of the

(*Continued on page* 146.)



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Archibald Vivian Hill

SECRETARY OF THE ROYAL SOCIETY

WILLIAM E. DICK

THE greatest revolutionary influence in the world to-day is the progress of modern science and modern technology. On that point there can be no doubt. Yet in the House of Commons, which should reflect our national life in all its aspects, there are only two scientists and but four engineers. Spokesman of this group, disproportionately small considering the importance of science and technology, is Prof. Archibald Vivian Hill, Independent Conservative M.P. for Cambridge University since 1940. He is more an independent than a Conservative, for he neither accepts the Tory whip nor belongs to the Conservative back-bencher's committee, and his actions since 1940 suggest that he is more strongly influenced by the deliberations of the council of the Royal Society, of which he has been a secretary since 1935, than by the political party which invited him to stand for parliament.

Hill's scientific work has been done in the realm of physiology, although had it not been for the persuasion of his tutor at Cambridge, the late Sir Walter Fletcher, he would most probably have continued his mathematical studies, after ranking as third wrangler in his year. But, thanks to Fletcher, Hill turned to physiology, a science which appealed to his inborn curiosity of wanting to know how things worked. The physiology laboratory at Cambridge was at that time the finest in the world; it was superbly equipped, and among the scientists then working there were such distinguished physiologists as Gowland Hopkins, E. D. Adrian and Joseph Barcroft. Turning back the pages of the *Journal of Physiology* we find an account of Hill's first independent research, into the recovery heat production of muscle. In the summary to that paper he ventured the observation that the amount of heat liberated when a muscle recovered after contraction was at least as great as that liberated during contraction. This idea, which later experiments proved to be remarkably accurate, was the starting point of his work on muscle. Further experiments showed that in the contraction phase lactic acid was produced in muscle and in the recovery

phase only a portion—about one fifth—of the lactic acid was oxidized, the remainder being built up again into another substance. In other words Hill was able to show that lactic acid was not merely the fuel used in muscular action, but part of the machinery itself.

Then came the Great War. Hill gave up his physiology research and joined the Cambridgeshire Regiment. He had always been interested in rifle shooting—indeed he says the development of his faculty for accurate observation owes much to that pastime—and he was eventually chosen to become musketry instructor to the East Anglian Division. Hill was then a captain. As the need to recall scientists from the fighting services became more urgent he was next transferred to the newly formed anti-aircraft experimental section of the Munitions Inventions department. It was this research team, led by Hill and including such famous names as R. H. Fowler, E. A. Milne and Douglas Hartree, that laid the foundations of the science of A.A. gunnery, which these scientists wrote up into a two-volume textbook. Hill's work as director of this unit, affectionately known by then as "Hill's Brigands", was recognized by his promotion to the rank of brevet major. Air defence has always remained one of Hill's keenest interests, and it was therefore only natural, when the Air Ministry appointed the Committee for the Scientific Survey of Air Defence in 1935, that he should have been chosen a member along with Sir Henry Tizard, Prof. P. M. S. Blackett and H. E. Wimperis. This committee can fairly be described as the midwife who attended at the birth of radiolocation. In this war, as in the last, Hill has been made an associate member of the Ordnance Board.

After the war he returned to his physiological research, the results of which can be found recorded in such books as *Chemical Wave Transmission in Nerve*, *Muscular Activity* and *Muscular Movement*, and the more popular *Living Machinery* and *Adventures in Biophysics*. In turn he held posts at Cambridge, Manchester, and University College, London, eventually becoming Foulerton research professor of the Royal Society in 1926, a post which he still holds. During the post-war period he was in close contact in connection with his researches into muscle physiology with Prof. Otto Meyerhof, the German research worker. Although they never collaborated in the same laboratory their researches ran so nearly parallel to that of the other that they were in constant correspondence, and it was altogether fitting that in 1922 they should have been jointly awarded the Nobel Prize.

Hill's own personal belief in the fundamental internationalism of science was a decade later to lead him to do all in his power to help the European members of the scientific fraternity whose independence—whose very existence even—was threatened by the coming of power of Hitler. He actively supported the Academic Assistance Council (from which has grown the Society for the Protection of Learning) from its inception under the presidency of Lord Rutherford. When the fifth-column scare which synchronized with the fall of France led to the stupid indiscriminate round-up of aliens in this country he became an active champion, both in the House and outside it, of the alien scientists whose talents were more valuable to the allied cause in the laboratory than in the internment camp. He helped to build up the scheme whereby the case papers of interned scientists compiled by the Society for the Protection of Learning were sifted by the Royal Society and recommendations then made to the Home Office to secure their release. The Home Office on occasions moved too slowly for Hill. One example of the way in which he brought shock tactics to bear on this problem of internees is provided by the case of F. G. Friedlander. Hill's own son had been elected a fellow of Trinity on the same day as Friedlander, who in spite of his education at an English school and at an English university had been interned. Prof. Hill called attention to the fact in the correspondence columns of *The Times* and the gentle sarcasm of the last sentence of his letter, "The action of the college [in electing Friedlander a fellow] seems more sensible than that of His Majesty's Government" must have struck home, for Friedlander was released from a Canadian internment camp within a week. Incidentally Hill's friend, Prof. Meyerhof, managed to escape from Germany and now holds an appointment at an American university.

As a secretary of the Royal Society, Hill became a member of the committee set up in the autumn of 1940 to advise the War Cabinet on scientific matters, and since 1939 he has been chairman of the scientific section of the Central Register. During this war he has spent three months with our embassy in Washington on special duties connected with scientific liaison between this country and the U.S.A.

Hill's wife is a sister of Lord Keynes, the economist. Their four children seem to have inherited their father's scientific talents. The elder son, a physiologist like his father, is at present scientific adviser to the First Army in North Africa; the other son is engaged on scientific work with the Admiralty. Of their two daughters the elder is an economist and works for the Board of Trade; the second daughter is qualified in medicine and is married to a doctor.

On politics Hill has at least one intriguing idea. He looks upon the wide range of political opinions as resembling the range of colours in the spectrum: the Conservative party, he considers, corresponds to the colours from ultra violet to orange, Liberals range from yellow to red, and so on, until one comes to the Communists, who vibrate faithfully on a narrow band in the infra red. Most people, except the most die-hard reactionary and the most oscillatory revolutionary, have more than one peak within the spectral range. He thinks the existing political parties offer too narrow a choice of wavelengths and he foresees a great future for a central party which selects a sound comprehensive waveband. He himself prefers to remain a political independent, free to oscillate on any wavelength.

Hill's activities in the political world—he has made good use of the short time he has been in the House of Commons—do not alter the fact that he is at heart much more interested in science than in politics. One hopes that for the duration of the war at least he will remain in the House of Commons, where he does such good work for the cause of science. He has told me, however, that he considers he is gradually becoming less and less of a scientist and more and more of "a general busybody" (his own words). He fears the time might come when people would forget that he was once engaged on scientific research! How long, one wonders, will Hill the scientist remain the member for Cambridge University? The world of science stands to lose whether he gives up politics for science, or vice versa.

The Dehydration of Foodstuffs

A REPORT ON AMERICAN PRACTICE

THE complex problems of supply imposed on the United Nations by the War have given rise to the development of the large-scale dehydration of foodstuffs. America is preparing dehydrated fruits, vegetables, soup powders, butter, meat, and a score of other foodstuffs in large quantities for the benefit of her own fighting forces and those of all the Allied Nations.

Most of the foodstuffs we eat contain much water. Eggs and meat contain about 75%, and some vegetables, over 90% of water. Even foods which appear to be quite dry contain 10% or more. The shipment of all this water throws an unnecessary strain on the transport available, and against this back-ground, the war-time significance of dried foods is appreciated (Fig. 1). Such products (including their containers) occupy on an average only about a quarter of the space required by the untreated foodstuff, and the weight is similarly reduced. In addition, many fresh foodstuffs, such as meat and many vegetables, require elaborate transport facilities, such as refrigerator ships, to keep them in good condition. Without these special arrangements, the foods would rapidly deteriorate. In the dried state, however, their storage life under comparable conditions is considerably extended, with resultant saving in shipping space, overheads, and transport costs.

America has long produced a large variety of dried fruits and vegetables, notably beans, peas, raisins, apples, prunes, peaches, apricots, and pears. Drying was largely used to preserve the product, such preservation of food being far from a new idea with the North American Indians and other even more primitive peoples. Indians in the Arizona region, for instance, have not had to be taught much about ths use of dried foods, as they have been long familiar with "jerky" beef, dried corn, and dried vegetables.

"Dried", "sun-dried", "evaporated" and "dehydrated" are the terms most frequently used to describe dried products. The first indicates the removal of the water content by any means whatever; the second implies drying without artificial heat; evaporation involves the use of artificial heat, the air circulation depending on natural draught, whilst the more recently developed techniques used in dehydration rely on the mechanical circulation of artificial heat, with rigid control of temperature, humidity, and air flow.

The water content of dried fruits usually lies between 20% and 25%, and of dried vegetables, between 10% and 15%. Properly dehydrated foods generally contain less than 7% of moisture, the figure usually being about 5%, but sometimes it may be as low as 3·5%. The weight ratios of the natural to the dehydrated product naturally depend on the water content of the raw material. Generally speaking, 1 lb. of the corresponding dehydrated commodity is produced from 10 lb. of fresh vegetables, over a gallon of skim milk, three dozen shell eggs, or 4 lb. of raw, lean meat.

During the first World War, nearly 9,000,000 lbs. of dehydrated products were shipped to the United States Army overseas, of which 70·3% was accounted for by potatoes, 20·9% by soup powder, and the remaining 8.8% by other foodstuffs. In the present conflict, the armed forces of the United States plan to purchase millions of pounds of dehydrated vegetables this year, largely made up of potatoes, cabbages, onions, sweet potatoes, beets, and rutabagas. Fruits, meat, and other products will be bought in addition. It is estimated that the elimination of water from potatoes alone will save the Army shipping space equivalent to that in two large freighters. One ship can carry as much food value in dehydrated products as nine ships could of the commodities in their natural forms. Plans are under way to dehydrate many more kinds of food.

The commercial dehydration of food is not a business to be undertaken carelessly. In the first World War, because many commercial concerns went into the dehydration business poorly equipped and with little understanding of the problems involved, dehydrated food was not a great success at that time. In general, the processes involved require equipment and control at least as specialised as that required for canning, and the successful operation of a dehydration plant is even more difficult than a cannery or quick-freeze establishment. Any concern undertaking dehydration under a lack of skilled and experienced direction will undoubtedly suffer losses until the business is learned. What is more important to-day is that the wastage of the foodstuffs involved cannot be permitted.

Processing of Fruit and Vegetables.

A large volume of research work has been undertaken, and the technical aspects of the processes involved are now much more fully understood than during the last war. The aim of the research was to evolve methods which would prevent the loss of minerals, vitamins and other nutritive elements, colours and flavour, whilst the products themselves would have to withstand storage, sometimes under drastic conditions, without undue deterioration, and would also have to ship well and closely resemble fresh foodstuffs when finally reconstituted.

High-quality dehybrated food can only be made from high-quality raw material. Dehydration techniques offer no magic to grade-up low-quality materials. The right variety of raw material must be chosen for dehydration. It must have been grown properly, it must have been harvested or slaughtered at the proper time, it must be promptly prepared for dehydration, and skilled attention must be given to the preparation, dehydration, packing, and storage of the product.

The main steps in preparing fruits and vegetables for dehydration are washing, grading for size, peeling, trimming, checking, sub-dividing, pitting and seeding, blanching, and traying.

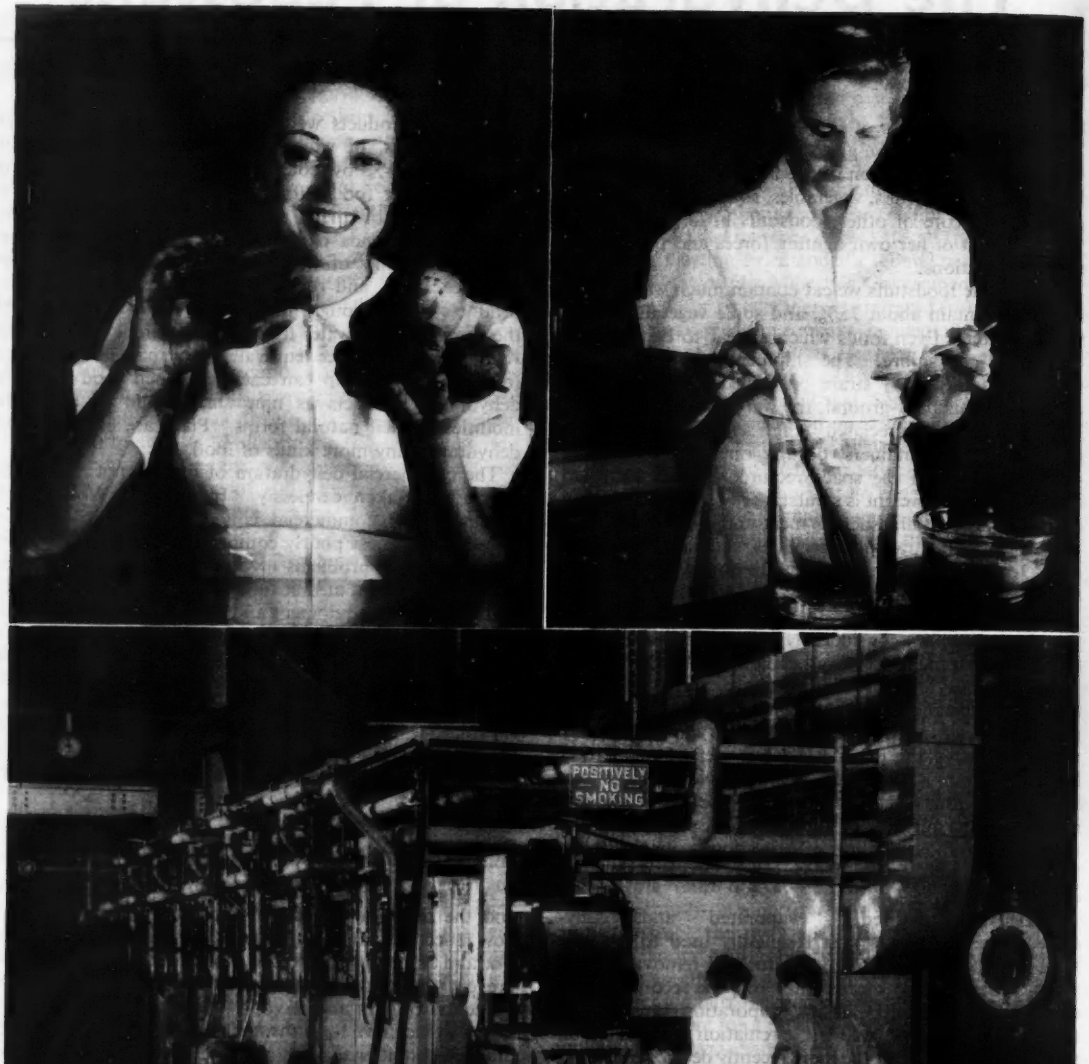

FIG. 1.—Dehydrated sweet potatoes occupy less space, and weigh less than the raw foodstuff. FIG. 2.—Trays of pre-treated cabbage being run into a semi-commercial scale tunnel dryer. The illustration gives some indication of the arrangements necessary for control of drying conditions. FIG. 3.—The great saving of shipping space afforded by dehydrated products is well illustrated by the small quantity of powder required to make a gallon of soup. The transport of the corresponding quantity of canned wet soup would be prohibitive.

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FIG. 4.—Dehydrated soup powder, in common with all other dehydrated products, is critically examined for flavour, colour, and texture.

The functions of most of these stages are self-evident, but pre-treatment known as blanching is necessary to make presentable dehydrated foods of good keeping quality from light-coloured fruits and vegetables. This treatment inactivates the peroxidases—enzymes or ferments which are very necessary to the normal life of plants, but damaging to their quality as foods if permitted to continue activity after harvesting and storing. Potatoes and carrots are usually water-blanched in Canada, while turnips and cabbage are generally steam-blanched. Steam blanching is used almost exclusively in the United States. In addition, light-coloured fruits are usually sulphured before dehydrating.

After this pre-treatment, the material is usually shredded or sliced, and dried in tunnel-type driers under strictly controlled conditions of temperature, humidity, and air-flow (Fig. 2).

The yield for most vegetables is from 4% to 14% of the fresh, unprepared material, though this runs as high as 18% in the case of parsnips, and from 17% to 21% in potatoes. While rhubarb may yield but 2% of the fresh prepared product as dehydrated food, the yield of most dehydrated fruits and berries averages about 15% of the fresh, unprepared product.

Considerable quantities of dehydrated, as distinguished from dried, apples are now being processed commercially in the United States, and bought by the U.S. Army. Rome Beauty, Baldwin, and Staymen Winesap varieties have been found ideal for making this product. The dehydrated product weighs only one seventh as much as the raw apples, and can be reconstituted readily to make apple sauce, pie filling, or fruit for eating with cereal. The product is superior in flavour to dried fruit. It keeps well, and does not go sour. Dehydrated apple is being packed in airproof, 5-gallon black-metal cans, and is the only dehydrated fruit being purchased by the Army except lemon.

More than 6,000,000 lb. of dehydrated soup have been bought for the Lease-Lend (Fig. 3), and over 500,000 lb. of dehydrated tomato flakes. Most of these products are manufactured by spraying cooked, pulped vegetables on to hot revolving drums where the water quickly evaporates. The dried product then peels off the drums like paper, is crumbled into flakes, and these latter become soup when water and seasoning are added (Fig. 4).

Dehydrated vegetables are usually packaged for Lease-Lend and the armed forces in 5-gallon tins with press-in lids which are spot-soldered on. Inert atmospheres are considered necessary to ensure satisfactory storage for

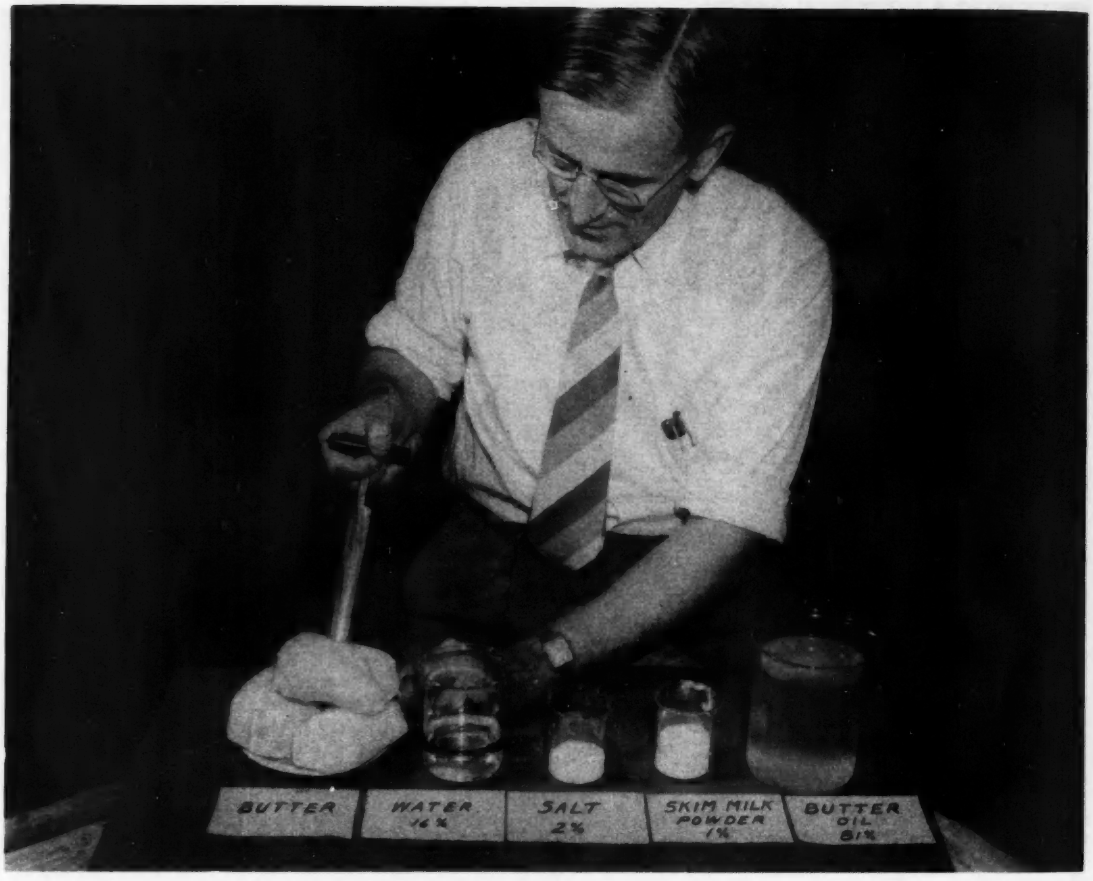


FIG. 5.—This illustration brings out clearly the composition of butter and the space saved by shipment of the dehydrated butter oil.

some of these commodities; either commercial nitrogen or carbon dioxide may be used. Thus, all cabbage, turnips, and carrots processed in Canada for government order are gas-packed, and in the United States, carrots and cabbage are similarly stored.

Dehydrated butter (or pure butter oil) is made by melting, floating off the fat, and vacuum-drying it (Fig. 5). Removal of the water itself tends to prevent adverse bacterial and chemical activity which brings on rancidity. But the gas must also be removed from the fat to prevent oxidation. Vacuum-drying in pans or with agitation accomplishes this. Packing either dehydrated whole milk or butter oil in an inert atmosphere may be rendered unnecessary if the products are made properly.

Butter oil keeps when properly made, even at room temperature. It can be used directly for cooking, or reconstituted into butter by the addition of water and salt. The fact that it can be shipped without refrigeration is important in war time.

Processing of Meat

THE process for the successful dehydration of meat has not yet been fully perfected, but an excellent product has already been turned out. Let it be said at the outset that this so far comes neither in the form of miniature steaks or chops, though it may do so in the future, nor are whole sides of beef dehydrated as such.

Here, as in the case with other foods, the dehydrator must start with a good product in order to end up with a good one. As has been said previously, low-quality raw material can never be processed into a high-quality dehydrated product, and mincing before dehydration sometimes tempts the use of low-grade cuts and meat full of gristle and stringy ligaments.

For dehydrating, fresh beef (or pork) is cut from the bones. Masses of fat are also dissected away, though from 20% to 30% of fat has been found permissible in experimental batches. The meat is next sliced into chunks and is then put through a sausage mill equipped to grind it into pieces about 1¼ inches in diameter. The material is now ready for dehydration.

In the current experiments of the U.S. Department of Agriculture, the ground meat is thrown between two heated drums which slowly revolve towards one another but do not quite meet (Fig. 6). They are set one-eighth of an inch apart. The drums are hollow and there is 100 lb. of steam pressure with a temperature of 337°F. inside.

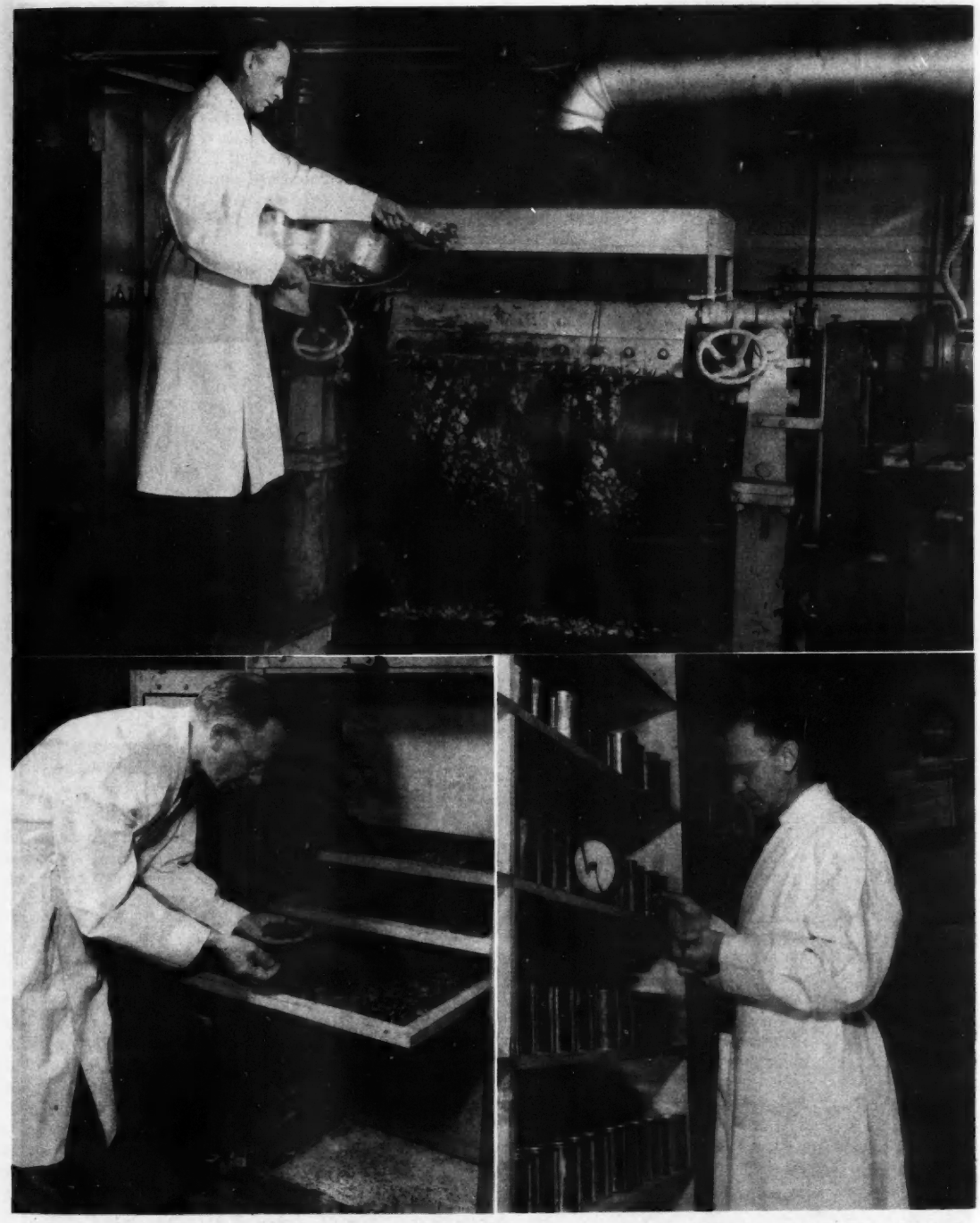


FIG. 6.—The meat, after trimming and grinding into lumps, is thrown between rotating, heated rollers, where cooking and partial dehydration takes place. Machines constructed on similar lines are used for the preparation of dehydrated soup powder and tomato flakes. FIG. 7.—Drying is completed in a cabinet drier similar in construction to those used for the preparation of vegetables. FIG. 8.—Samples of the product, in common with samples of all other dehydrated commodities, are subject to searching tests to ascertain their keeping qualities at elevated temperatures.

FIG. 9.—At its Western Regional Research Laboratory, the U.S. Department of Agriculture tries out on a semi-commercial scale different methods for the dehydration of fruits and vegetables in various types of dryers. What material makes the best containers for dehydrated vegetables? Many different kinds are under test in the laboratory.

They usually make a complete revolution in less than a minute. The meat is in actual contact with the heated drums for from 40 to 60 seconds in different experimental batches.

This treatment not only cooks, coagulates, and shreds the meat, but also acts as a blanching process and partially dehydrates it as well. Within three-quarters of a minute the meat loses from 45% to 50% of its water content. Scrapers automatically remove the cooked meat from the revolving drums and it falls into trays beneath. From these it is transferred to other mesh-bottomed trays which are slipped into a cabinet drier for two or three hours at 160°F. (Fig. 7). The water content of the meat is now reduced to 5% and it is ready to be packed.

The final product occupies about half the volume of the original raw meat and weighs about a quarter as much. It can be still further compressed in packing if desired. The exposure to heat inactivates all enzymes present and kills the bacteria. From 20 lb. of fresh meat, 5·3 lb. of dehydrated were produced in one run. That would mean that the ordinary steer yielding 354 lb. of lean beef would yield about 88½ lb. of dehydrated product.

The product is palatable for the satisfaction of hunger eaten without preparation, but to reconstitute it two or three parts of water are added. The product stands in this water for 1 hour, after which it is boiled vigorously for 10 minutes and simmered for 20 more. Subsequent cooking depends on the type of dish to be prepared. The meat can be used for meat-loaf, in hamburger, or to make stew. So prepared the dehydrated product gives the person who eats it something really to bite on. Dehydrated meat contains from 55% to 78% of protein, depending on the amount of fat present, and is a good source of the vitamin B complex, iron, phosphorus, and copper.

Further experimentation is still under way on cooking and drying temperatures and equipment, the permissible fat and moisture content of the raw material, and on the keeping quality of the product when stored under variable conditions—at 0°, 35°, and 110°F., and at room temperature (Fig. 8). Once more the fat is a constituent that may become rancid unless carefully handled. Samples of dehydrated meat are also being tested in Department of Agriculture's laboratories for moisture and fat content, changes in protein, mineral and vitamin content, and other qualities, after storage. Feeding to laboratory animals is part of the procedure. Samples are also submitted to cooking and eating tests by experienced judges of meat quality, and it has been proved that a satisfactory product can be turned out (Fig. 9).

As with many other products involving processes of a highly technical nature, dehydrated foodstuffs have received a considerable stimulus as a result of the war emergency. However, unlike many of these technical products, which are designed to destroy and kill, the immediate stimulus to the production of dehydrated foodstuffs is to supply the forces of the United Nations with a sound, palatable, and healthy dietary. When the war has been won, and the use of guns and tanks a thing of the past, dehydrated foodstuffs may find a practical place in our kitchens, and the war will have made a small, but nevertheless positive, contribution to human convenience.

The Night Sky in June

M. DAVIDSON D.Sc., F.R.A.S.

THE new moon occurs on June 2d. 22h. 33m., U.T., and full moon on June 18d. 05h. 14m. No important occultations take place during the month. The following conjunctions occur:

June

1d. 17h.	Venus in conjunction with Jupiter,			Venus	2°·1	N.
1d. 19h.	Mercury	,,	Moon	Mercury	0·1	N.
6d. 14h.	Jupiter	,,	,,	Jupiter	2	N.
7d. 00h.	Venus	,,	,,	Venus	4	N.
26d. 05h.	Mars	,,	,,	Mars	3	N.
30d. 05h.	Mercury	,,	Saturn	Mercury	0·1	S.
30d. 19h.	Saturn	,,	Moon	Saturn	3	N.
30d. 21h.	Mercury	,,	,,	Mercury	3	N.

The Planets.—Mercury attains its greatest western elongation, 23°, on June 18. The planet rises at 2h. 56m. and sets at 17h. 56m. on that day. Venus attains the greatest eastern elongation, 45°, on June 28, rising at 7h. 50m. and setting at 22h. 38m. In the middle of the month Mars rises at 1h. and sets at 13h. 42m. Jupiter rises at 6h. 37m. in the middle of the month and sets at 22h. 21m. Saturn is in conjunction with the sun on June 7 and is no longer visible. To assist with the observation of the planets, the times of rising and setting of the Sun are given for a few dates under separate heading.

Observation of Jupiter.—Mr. B. M. Peek noticed a remarkable outbreak of activity in Jupiter's South Equatorial Belt early in February, and it is possible that something similar to what took place in 1928-29 is occurring. The phenomenon has been seen since by other observers of Jupiter's physical features and those who make a study of the planet should look out for any unusual appearances in the South Equatorial Belt. Unfortunately the long days and the double summer time make observations somewhat difficult during the month. Also, as will be seen from the following table, Jupiter sets about 2 hours after the sun.

Approximate Times of Rising and Setting of the Sun —

Date.	Time of Sunrise.	Time of Sunset.
June 1	3h. 49m.	20h. 07m.
8	3h. 44m.	20h. 14m.
15	3h. 42m.	20h. 17m.
22	3h. 42m.	20h. 21m.
29	3h. 45m.	20h. 21m.

All times are given in Universal Time and the latitude of Greenwich is assumed.

Diphtheria Immunization

J. GREENWOOD WILSON, M.D., F.R.C.P.
Medical Officer of Health, City of Cardiff

MEDICINE is an art and not a science. Those who fail to understand this elementary truth may wonder why progress in the application of the scientific method in the art of preventive and curative medicine is slow by comparison with that so evidently made in other spheres of human activity. We have the modern miracles of aviation and radio, but we are still unable to prevent or cure the common cold. The reason is that medicine deals with human beings. The January issue of *Discovery* displayed in its cover design a photograph of a laboratory worker making a precision observation. Yet she herself is a kind of living laboratory teeming with manifold activities, all of which must be successfully executed if she is to complete her observation with precision. The accuracy of the processes going on inside the human body is so great that it is extraordinarily difficult to apply the scientific method to their appraisal. For example, the acid-alkali balance in human blood is in so fine a state of equilibrium that minutest deviations may cause major symptoms of illness—towards too much acid giving symptoms of acidosis and towards too much alkali giving symptoms of alkalosis. Yet, scientifically speaking it is hardly accurate to speak of deviations towards "too much acid" or "too much alkali"; rather, one should content oneself with saying that if the minutest element of disequilibrium appears in the acid-base relationship grave symptoms of acidosis or of alkalosis may appear. Similar considerations apply to the "physics" of various processes in the body, e.g. the exchange of gases in the lung capillaries. Further complication arises from the fact that these same highly delicate chemical and physical processes may be suddenly and strongly influenced by the emotions, which may, for example, activate the primitive mechanisms for fight or flight which have come down to us through our animal inheritance.

All these are but a few of the difficulties in the way of obtaining an understanding of the workings of the human body as completely scientific as our modern knowledge of, say, atomic energy, television, or aerodynamics; and, so far, we have only considered the working of the human economy as an independent unit. When we come to study the relationship between man and his environment we face added difficulties. To this day we have little detailed knowledge of the effect upon man of climate and of atmospheric pollution. Considerable advances have been made, however, in the study of one aspect of the relationship between man and his environment, and that is through the science of bacteriology, which has shown us that in the words of St. Paul "we are compassed about with so great a cloud of witnesses", such myriads of invisible micro-organisms, that it is essential for the human body to maintain its state of equilibrium not only as between opposing chemical and physical processes continuously going on within itself, but also as between itself and the multitude of living micro-organisms surrounding it. If it fails in that almost continuous adjustment, the result is what we call disease—bacterial or germ disease. If the failure of adjustment is a physico-chemical one, the result is what doctors call a disease of metabolism. When disease germs gain a hold on the human organism they are said to be parasitic upon it. They live and multiply at the expense of the human host. As a result of their activities, a state of fluctuating equilibrium is set up in the tissues of the host, which leads to a change in the normal biochemical relationships. The germ attempts to adapt its environment (in this instance, the human body) to suit its own requirements, and the body opposes, as best it can, the activity of the invading parasite. The resultant infection depends upon two variable factors—the power of the infecting germ or micro-organism to affect the host, and the defence which the host's tissues offer to the assault of the invading germ. For complete understanding of the precise manner in which the invading germs or germ-products bring about changes in the human body we must wait upon fuller knowledge of the complex physico-chemical processes of human metabolism to which reference has already been made. But we do know something of the invaders' weapons and something of the human body's modes of defence.

Germs and Toxins

A germ that is multiplying within a human body may contain a poison inside itself which is only released to exert its effect upon the body tissues when the germ has been destroyed or disintegrated by the body's defensive mechanisms. When such germs are "grown" outside the human body in the laboratory it is difficult or impossible to separate from them the poison that is normally formed within them when they are growing in their own "natural" environment. Germ poisons are known as "toxins" and such internal germ poisons are known as "*endo*toxins". Certain other germs produce a poison *outside* themselves while they grow, wherever that may be, whether in the human body or in laboratory "culture". These poisons are known as "*exo*toxins", and typical examples of the germs that produce them are the germs of tetanus and diphtheria. It is important to note that the toxins produced by this group of germs can be found not only in the blood stream of human beings and other animals infected by them but also in the artificial media in which they are grown ("cultured") in the laboratory. When a person is said to be suffering from "blood-poisoning", what is really meant is that infecting germs have succeeded in gaining entrance into the blood and multiplying there so that by being carried round the body in the bloodstream they can reach every part of it and set up multiple foci of infection.

When a patient is infected with diphtheria, the illness is caused not by the entrance into and multiplication in the bloodstream of the germs of diphtheria but by their multi-

plication in the superficial tissues of the body (usually those of the throat, nose and windpipe—in that order of attack) and the resulting circulation in the bloodstream of the poison or toxin (exotoxin) manufactured by them as a natural concomitant of their continuing to live and multiply. The characteristic symptoms of diphtheria are caused by the circulation through the patient's bloodstream and body fluids of this toxin, which has a selective action on certain organs of the body such as the heart and nerves with resulting heart failure and muscular paralysis. If the toxin be the diphtheria invaders' weapon of offence what is the body's mode of defence? The answer is that the body produces a substance which counters the toxin and "fixes" it so that it can no longer do any harm. Volumes have been written to explain exactly how it occurs. Scientists who specialize on this work have a clear understanding of the process. The body's defence weapon which opposes the toxin is known as antitoxin. The amount present in the blood can be measured and expressed in terms of units. Scientists have observed how the antitoxin content rises in the blood of a human being who is successfully resisting an attack of diphtheria. Similarly the diphtheria toxin can be studied and measured when diphtheria germs are allowed to multiply or are "cultured" under laboratory conditions. Furthermore, it has been found that by treatment with heat or with certain chemicals the toxin can be robbed of its deadly effects but yet retain its power to stimulate the formation of antitoxin. This is the fundamental principle underlying the scientific treatment of an immunization against diphtheria. The recovery or death of an untreated person suffering from diphtheria depends on his ability or failure to produce antitoxin in such quantities and at such a speed that the invading toxin can be adequately neutralized or fixed almost as quickly as it is formed.

The "Willing Horse"

It has been explained that diphtheria toxin can be robbed of its lethal properties but allowed to retain its power to stimulate the formation of antitoxin. This emasculated product is known as toxoid. When toxoid is injected into horses in suitable doses, antitoxin is produced in their blood in large quantities. We know that human beings, especially since the war, have been asked to come forward in large numbers to give their blood for blood transfusion in case of war emergency, such as the urgent treatment of severely shocked air raid casualties. It is known that persons who give their blood in this way suffer little or no inconvenience and after a brief rest are able to resume normal activity without feeling any the worse. Some say they feel all the better for it. The term "willing horse" has crept into our vocabulary to connote faithful service. The "willing horse", having been previously injected or "immunized" with diphtheria toxoid, is able to give its blood to save human lives with a far greater certainty of success in the use of its gift than the human blood donor; and as with human blood donors, it can be asserted with confidence that horses that give their blood in this way suffer little or no inconvenience and are none the worse for their service. The blood of horses thus obtained after suitably graduated doses of diphtheria toxoid contains a high content of antitoxin. The clear portion (serum) of the horses' blood, having been separated off in the laboratory, can be sterilized, put up into clean sterile ampoules, and stored for use on demand in the treatment of diphtheria patients. The essential factor for success in the use of antitoxin to save the lives of patients suffering from diphtheria is that it should be given as early as possible after the patients have first become infected.

In 1891 the first child desperately ill from diphtheria was treated with antitoxin. In 1894 Dr. Roux informed an International Congress at Budapest that following the routine antitoxin treatment of children suffering from diphtheria in the Paris Children's Hospital the mortality had already been reduced from 52% to 25%. In a modern isolation hospital in this country the figures for the year's work in treating diphtheria during 1941 showed a mortality rate of only 3·36% as an average figure. In cases where no antitoxin was given at all the mortality rate was 100%, but in cases where it was given on the second day of the disease the figure was less than 1%. If by misfortune it was not possible to give antitoxin treatment till the third day of the disease the mortality figure rose to 4·26%. In England and Wales during the decennium 1871-1880 the average number of deaths per annum from diphtheria (irrespective of how, when and where they were treated) was 120 per 1,000,000 of the population. In the year 1938 the corresponding figure was 71 per 1,000,000 population. These figures are given because there are some who contend that the introduction of antitoxin has produced no greater improvement in the diphtheria mortality results than could have been obtained by "natural means", i.e. by the effects of improved sanitation and housing and generally raised standard of living. In considering this contention, it is important to remember that the national mortality figures given as already said, *take no account of how, when and where the case was treated*, or of what day in the course of the disease treatment was commenced. The modern hospital figures quoted, which could be paralleled by corresponding figures from similar institutions throughout England and Wales, illustrate the reasons why, despite the discovery of antitoxin for the treatment of diphtheria, the mortality figures for diphtheria in England and Wales have not fallen to a greater extent than from 120 to 71 per 1,000,000 population.

Principal Killer of Children

Nevertheless, it is true that diphtheria still remains the principal killer of children of school age, and that is why no effort should be spared to prevent as many children as possible from contracting the disease. This can be done. Antitoxin itself if given to a person who has been in close contact with a case of diphtheria (e.g. brother or sister) will protect that person *for the time being* (2 or 3 weeks) from contracting the disease. This process may be compared to the action taken in ancient Rome at one stage of its history when "hired mercenaries" were called in to repel invaders. Scientists have discovered a way of training the body to defend itself against the onslaughts of diphtheria, to manufacture its own antitoxin. Modern Rome broadcasting recently in reference to the success of the Eighth Army said it was *perfectly trained*. It wasn't trained by trusting to luck until it met the enemy. Army training becomes increasingly complex and strenuous *long*

before it is anticipated to meet the enemy. The defence forces of the body can be trained much more simply, but not entirely without a little trouble and perhaps discomfort.

Diphtheria toxin, the offensive weapon of the diphtheria disease, can be robbed of its dangerous properties but allowed to retain its powers of stimulating the formation of the defensive antitoxin. Toxin treated in this way is known as "toxoid". This was explained in discussing how we obtain from horses' blood, antitoxin for use in treating diphtheria or in giving temporary defence of the diphtheria contact—like the hired mercenaries. But this same toxoid when injected in suitable doses even into infants can stimulate in them the formation of antitoxin so that when, perhaps years later, they meet the enemy, diphtheria, either their defensive antitoxin is still fully mobilized in their blood or at least their defensive mechanism is in such good trim that antitoxin will be mobilized at lightning speed and rushed to the point of invasion in time in most cases to repel it immediately and prevent disease altogether, or at worst to limit the invasion so that there is only a very mild attack of diphtheria ending in complete recovery without any after-effects, and without risk of death. This process of injecting diphtheria toxoid into human beings in order to *train* their bodies successfully in defence against diphtheria, is known as diphtheria immunization. *It has been estimated that in Great Britain, of* 100 *children born and not immunized* 10 *will contract diphtheria and* 1 *will die; of every* 100 *children immunized,* 1 *will contract a mild form of diphtheria and none will die.* It is true that when a patient recovers from diphtheria a *natural* process is brought into being exactly like that which follows the *artificial* stimulus of antitoxin formation in the body following diphtheria immunization. In the latter process, diphtheria *toxoid* is injected almost painlessly by the doctor's syringe, in the former, *toxin* is poured into the blood from the diphtheria germs multiplying in the superficial tissues of the patient. It is well for the patient to recover in this way and by the "natural" exertion of his own defensive mechanism, but at what cost of unnecessary suffering, anxiety and possibly after-effects.

An American Lesson

And what a difference in the cost! It costs about 50 times more to treat a patient suffering from diphtheria, even successfully, than it does to immunize him. The Americans can teach the British a lesson in community adoption of diphtheria immunization as a routine measure of protection. In New York City, where immunization was begun in 1918 and an intensive campaign to secure the routine immunization of all children against diphtheria was begun in January, 1929, results were obtained which viewed in the light of the figures now to be reproduced can only be described as striking.

Year.	*Cases.*	*Deaths.*	*Deaths per 100,000 Children under 15*
1910-19 (average)	14,282	1,290	83·0
1920-29 (average)	10,685	684	42·0
1930	3,794	198	11·7
1931	3,999	186	11·0
1932	3,581	210	12·4
1933	1,891	86	5·1
1934	1,593	103	6·1
1935	1,189	68	4·0
1936	1,124	35	2·1
1937	1,184	58	3·6
1938	700	26	1·6
1939	564	22	1·4
1940	408	10	0·7

These figures are accepted by scientists everywhere on their face value. Those who prepared them and those who did the work from which they result had no personal axe to grind. They were not seeking to "sell" for commercial profit a new invention. They were labouring as is scientists' wont, for the benefit of mankind, and they are reproduced here from the same motive, as evidence of what can be done if only the general public will rise to the occasion and seize the opportunity of co-operating in the application of this great measure of scientific preventive medicine.

Few people hesitate to insure themselves against risks of everyday life which at the time when they pay their premiums may seem (in relation to the amount of those premiums!) to be almost unjustifiably remote. For infinitely less time, trouble and expense they can insure their children against diphtheria. Instead of rushing to secure so great a prize they seem to prefer to spend money in taxation and rates, because public health administrators are compelled by *their* sense of public duty to undertake expensive propaganda campaigns in favour of the diphtheria immunization whose virtues are so widely ignored. Some even contribute generously to those who conduct expensive campaigns of *counter*-propaganda. "*Quem deus perdere vult, prius dementat.*"

OPTICS AND AVIATION—*Continued from page* 134.

retina, which blacks-out vision until the return of normal blood pressure. Livingston postulates that all parts of the visual tract are concerned in the process, depending on the force of "g" applied. Lower degrees of "g" cause simple visual black-out due to action on the central artery of the retina, on the lower visual centres or relay stations in the midbrain and on the cortico-visual area; greater "g" causes not only black-out but also emotional states or loss of power of thought by additional action on the cerebral cortical area, which represents conscious mental processes and initiates effect or responses.

Preventive measures were first introduced by the pilots, whose personal experiences proved that some relief could be obtained by yelling loudly during a steep turn or sharp pull-out. This action contracts the muscles of the abdominal wall and raises the diaphragm, thus lessening the fall of blood pressure. The most simple and effective means of lessening the effects of a high "g" consists of keeping the pilots physically fit.

Science for Freedom: 1543-1943

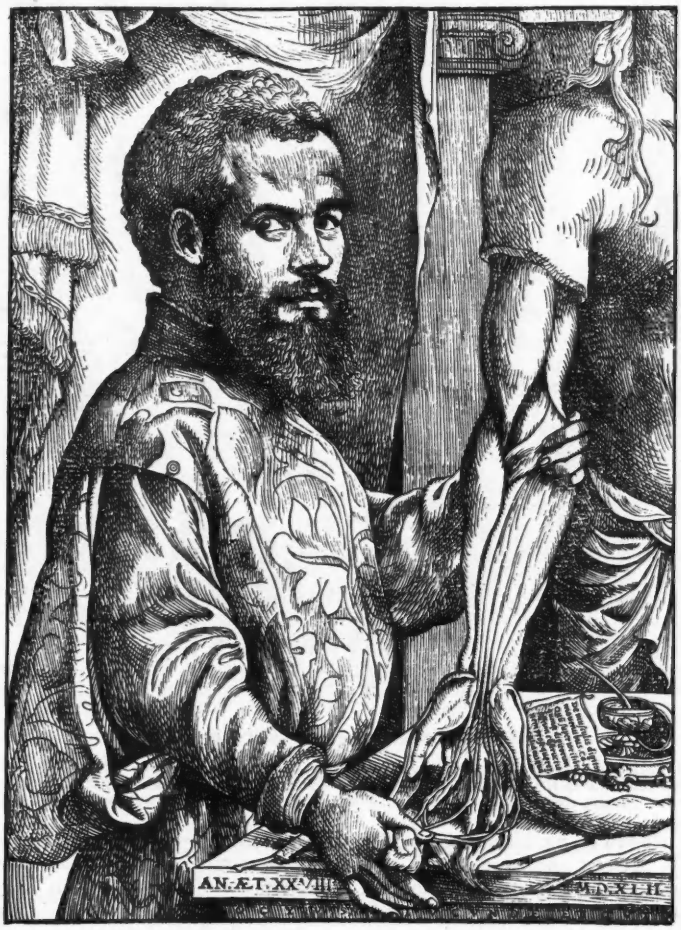
[CONCLUSION]

S. LILLEY, Ph.D.

[In the first part of this article Dr. Lilley discussed the struggle for freedom of scientific thought which was begun in 1543 by Copernicus and Vesalius. He outlined the differences between the Copernican theory of the universe and the Aristotelian theory orthodox at the time, and suggested that this difference was not in itself sufficient to explain the bitter persecution of those who advocated the new views. Below the philosophical issues lay a deeper political struggle between dying feudalism and rising capitalist democracy. The Aristotelian philosophy, he showed, could be a useful political weapon to the reactionary feudal classes—hence the persecution of those who disputed it. This persecution rose slowly at first, but later became very violent, and many supporters of the Copernican theory suffered greatly for their beliefs.]

PERHAPS the most important of these was Giordano Bruno, an unfrocked Italian priest, who wandered for years over Europe and eventually in 1583 found in England an intellectual atmosphere in which he could put into coherent form the extremely revolutionary scientific philosophy which he was evolving. In this he accepted Copernicus' theory, but extended its implications.

Copernicus, though he had declared himself unable to decide whether the universe be finite or infinite in extent, had in fact assumed it finite and left the stars, as of old, fixed in a crystal sphere with the sun at its centre. He had shifted the earth from the centre of the universe only to put the sun in its place. Bruno vastly extended our conception of the universe. To him the universe was infinite. The sun was one of the fixed stars. There was an infinite number of stars, ranged at random through infinite space, around each of which circulated a planetary system like our own, perhaps with life on some of the planets.



Reproduced from "History of Science, Technology and Philosophy in the XVIth and XVIIth Centuries" by A. Wolf, published by George Allen & Unwin, Ltd., London.

FIG. 3.—Andreas Vesalius.

Copernicus had effectively marshalled the arguments of relative motion to show that the best explanation of the apparent motion of the heavens was obtained by assuming the earth to move. Yet he declared the sun to be central and stationary. Bruno, realizing the full implications of relativity of motion, insisted that there could be no absolute motion, no absolute position, but only position and motion relative to some other body. Hence, he deduced, the sun moves and all the fixed stars are in motion relative to one another. And there is no centre

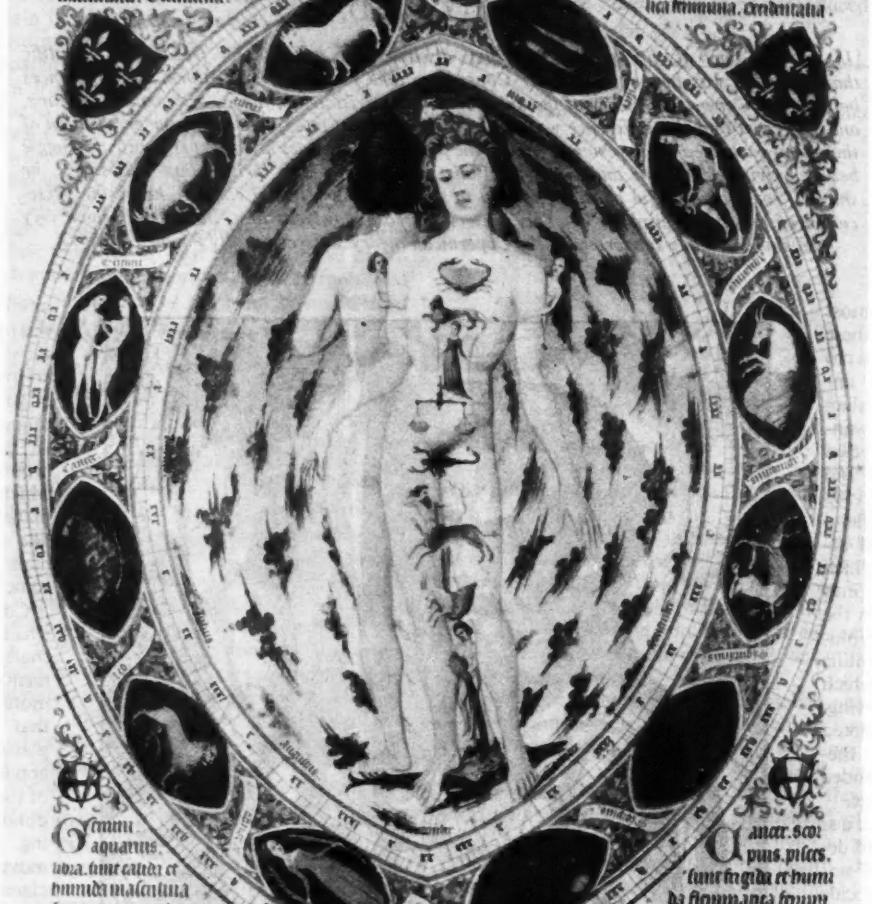


FIG. 6—" L'homme anatomique " by Pol de Limbourg.

Top left—Aries, Leo, Sagittarius possess hot, dry, masculine spirits (Eastern). *Top right*—Taurus, Virgo, Capricornus possess cold, dry, melancholic, feminine spirits (Western). *Bottom left*—Gemini, Aquarius, Libra possess hot, humid, war-like masculine spirits (Southern). *Bottom right*—Cancer, Scorpion, Pisces possess cold, humid, phlegmatic, feminine spirits (Northern).

of the universe. Bruno allowed no hierarchical distinction between one part of the universe and another, and thus the spread of his thought would have removed the last vestige of a chance of using false analogies (directly or in general mode of thought) between the physical universe and society for political ends. His type of thought applied to society (as he did to some extent apply it) left one free to work out what society *ought* to be like, in accordance with the observed needs and behaviour of men.

But Bruno's philosophy broke new ground in other fields than astronomy, and to put these in perspective it will be well to retrace our step for a moment to the other daring declaration of 1543: Vesalius' statement that Galen was wrong in regard to the septum of the heart.

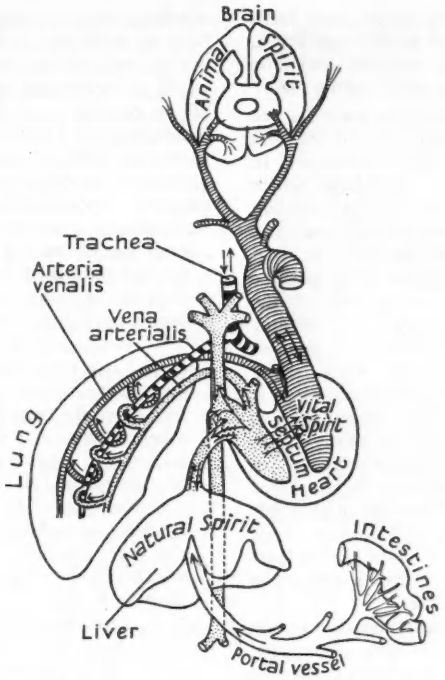
In the biological sphere, as in the physical, authority was in the sixteenth century regarded as the only road to truth. Aristotle was not, however, the authority. It would have been much better if he had been. For Aristotle's biological work, done after the expansion of the Greek world with the Alexandrian conquests in a time of social turmoil

and creative thought, was much superior to his physical treatises written earlier in the oppressive atmosphere of an Athens which had passed its zenith, lost its democracy, and come to be dominated — intellectually as well aspolitically—by conservative wealth. Aristotle's biology, in spite of many weaknesses, shows much more of the spirit of scientific research than does his physics. In spite of that, perhaps because of that, Aristotle was not regarded as *the* authority in matters biological. That position was held by the late Roman medical man, Galen. Galen, too, had done considerable research, but the part of his work which most influenced feudal Europe was his general theory, which was just as teleological as Aristotle's physics.

That theory attributed the working of the human body to various "Spirits", conceived as half-material, half-supernatural. The blood, carrying "Natural Spirits", moves in the veins only, where it surges tidally to and from the liver. Some of the blood is carried to the right ventricle of the heart; most of this merely discharges impurities there and returns to the liver, but some passes through the septum into the left ventricle (this is the point which Vesalius challenged). There it mingles with air from the lungs to form the higher and more subtle "Vital Spirits", which are carried to various parts of the body by the arteries. Some of the "Vital Spirits" go to the brain, there to be transformed into "Animal Spirits" (spirits of the soul), which are distributed by the nerves to all parts of the body. The Vital Spirits were thought to be responsible for the life of the body, but only in its more mechanical aspects; the soulfulness, the purposiveness, of life was directed by the Animal Spirits.

To Galen every organ of the body obtains its form, structure, and mode of action in order to fulfill its purpose, which is part of the Great Purpose, the teleological purpose of the whole universe. Hence, by a short step, every organ and every function, physical and mental, became associated with the larger aspects of the universe, especially with the planets, which were supposed to influence greatly the workings of the body. Such phrases as a "mercurial temperament", a "jovial humour", are relics of this theory (a "humour", of course, being a fluid not unlike the "Spirits").

This theory, too, was well adapted to the ideology of feudalism. Just as with Aristotelian cosmology, its conception of everything fitting into a Great Purpose exactly mirrored the social ideas which feudalism required and could easily be used to justify those ideas as absolute truth. Any attack on it was therefore once more an indirect attack on feudalism. Besides, to attack it was to undermine the principle of authority, here personified in Galen, as the only true road to knowledge—a principle which the reactionaries must always seek to maintain.



Reproduced from Charles Singer's "A Short History of Science" (Clarendon Press).

FIG. 7.—Galen's Philosophy.

Towards a Rational Biology

The passage from Vesalius, quoted in the second paragraph of this article[1], was the first step towards a rational human anatomy and physiology. Not many years later it was followed up by Servetus, who discovered the lesser circulation of the blood (between the lungs and the heart), and by Realdus Columbus, who arrived at the same result, possibly independently, in 1559. In that way sixteenth-century Europe was advancing towards a rational conception of the workings of the human body, though progress was much slower than in physics and astronomy. The first really big step did not come till 1628, when Harvey published his treatise on the circulation of the blood, opening the way for the explanation of much of the body's behaviour in mechanical, and later in chemical, terms.

Bruno was by no means a consistent materialist, rather he was a pantheist, but this passage and others like it state brilliantly, if crudely, the materialist point of view that the higher activities of man arise from the complex organization of his body rather than from any outside endowment of spirit. Directly contradicting the orthodox Galenic doctrine which attributed all the organization of the body to some sort of spiritual influence or universal purposiveness, it was bound to rouse the anger of the conservative.

But meanwhile, Bruno, to whom we now return, had gone a long way towards realizing the importance of the body and had reached conclusions that very directly challenged the orthodox ideology. To him the physical form of an organ determined its function, not conversely. He taught that the domination of man over the animals was due not so much to his mental faculties as to his hands and their amazing adaptability, that it was through using the hands that the mind was developed—a direct challenge to the orthodox doctrine which always put the spiritual on top. In one magnificent passage he wrote:

> "Could the form of a snake change; could its head mould itself into human form, its belly swell and grow into the shape of the human breast, its tongue enlarge,

[1] "Not long ago I would not have dared to turn aside even a hair's-breadth from Galen. But the septum of the heart is as thick, dense and compact as the rest of the heart. I do not see, therefore, how even the smallest particle can be transferred from the right to the left ventricle through the septum."

shoulders spread out and arms and hands shoot forth from it, and its tail bud into legs, it would understand, breathe, speak, work and walk like a man, and seem to be so because it would have become no other than a man."

Bruno's contribution to the advance of science did not lie in new empirical discoveries. Much that he held has since proved to be false. Rather his achievement was to conceive a maximum programme of the things which science should be willing to consider. The Aristotelian and Galenic approach laid down a minimum programme: "Such and such things are absolutely true, such and such inconceivable; within these limits you may investigate the details"—for example, the earth is fixed and all the celestial bodies move round it in circles, but you may investigate their exact positions and velocities. Bruno's attitude, if we may attribute to him words which he did not say, was: "These things are conceivable; there is no evidence as yet against them; we must regard them as possible, or even probable, unless science proves them false. We must not assume any particular relations between the parts of the universe or attribute special positions and motions to any of them until observation makes this necessary"—for example, all motion and position being relative, there is no *a priori* reason for assuming any part of the universe fixed, so we assume everything to be in motion unless we can prove it otherwise.

And, above all, Bruno taught that there is nothing permanent about the universe. Everything continually changes, though nothing disappears, and science must be prepared to investigate a changing world. "This entire globe, this star [but he means the earth] not being subject to death, and dissolution and annihilation being impossible everywhere in Nature, from time to time renews itself by changing and altering all its parts."

This last, more than anything else in his teaching, challenged the whole basis of feudalism, which to maintain itself must make men believe that change was illusory at both the physical and the social level. But almost everything Bruno preached threatened the ideology of the established order, so that it is not surprising that he paid the highest penalty when he fell into the hands of those most interested in the preservation of that order. In 1592 he was brought before the Inquisition at Venice. Venice, however, was one of the more advanced States economically and politically. The temporal authority, fearful of the political influence of the Roman Inquisition, refused to admit it to Venetian territory and severely limited and controlled the separate Inquisition which sat at Venice. The political motives which lay beneath the trial of Bruno are shown by the fact that this Venetian Inquisition, freer from the influence of feudal reaction, was unwilling to convict him. Then strong pressure was exerted on the Venetian authorities to have Bruno transferred to Rome. Venice for a time resisted, but eventually found it expedient to agree. Bruno was moved to Rome in 1593 and, after years of imprisonment, burned at the stake in 1600.

At his trial he summed up the situation in the stirring words, "Perchance you who condemn are in greater fear than I who am condemned".

The Peak of the Struggle

One hundred years after the publication of *De Revolutionibus* and *De Fabrica* the struggle for freedom was reaching a crisis. Descartes, for instance, having recovered from his initial fear, was publishing a series of books setting out the basis of the scientific method and explaining the world in mechanical terms. Galileo, who had spent his life in conflict with the Aristotelians, who had stoutly maintained the Copernican theory, who had contributed to the downfall of the old philosophy by countless discoveries of his own, from the true law of falling bodies to sunspots (imperfections in a celestial body!—this the Aristotelians could not tolerate) and to the satellites of Jupiter, demonstrating the Copernican theory in miniature —Galileo died in the prison of the Inquisition in 1642.

And the new spirit in the fight for freedom is shown in Milton's reference in 1644 to that great scientist:

> "And lest som should perswade ye, Lords and Commons! that these arguments of lerned mens discouragement at this your Order, are meer flourishes, and not reall, I could recount what I have seen and heard in other Countries, where this Kind of Inquisition tyrannizes; when I have sat among their learned men, for that honor I had, and bin counted happy to be born in such a place of *Philosophic* Freedom, as they suppos'd England was while themselves did nothing but bemoan the servil condition into which Lerning amongst them was brought; that this was it which had dampt the glory of Italian wits; that nothing had bin there writt'n now these many years but flattery and fustian. There it was that I found and visited the famous *Galileo* grown old, a prisoner of the Inquisition, for thinking in Astronomy otherwise than the Franciscan and Dominican Licensers thought."

Milton here was making a plea "For the Liberty of Unlicenc'd Printing". That was merely one of the signs that the struggle for freedom was now chiefly centred in England, the reactionaries having for the moment triumphed elsewhere. Other signs were not wanting. About the same time the Invisible College began to meet at Oxford—a few earnest men who were seeking to establish the methods of science over those of authority and tradition. And in 1645 Hobbes published his *Leviathan*, putting forward in the large the mechanical view of the world which was ousting the teleological.

But a few years earlier a bigger event for science had taken place. The English Revolution had begun. And within a few years England had, first in the world, overthrown all the main restraints of feudalism. With democracy came freedom for science, and English science began to lead the whole world.

Thus ended the first stage in the struggle for scientific freedom.

Science in Europe To-day

The third paragraph of this article began with the words: "It is difficult to conceive nowadays that any inordinate bravery should have been involved in these two actions", (the actons referred to being the publication by Copernicus and Vesalius of works disputing accepted scientific theories). That statement might have been true ten years ago, but to-day it is not difficult to conceive such a situation, since it actually exists on the continent of Europe. Just as feudalism feared science as a threat to its existence, so also does Fascism fear science, for scientific truth will destroy the whole basis of Fascism. The facts of the

destruction of science by the Nazis are well-known—numbers of students of science reduced by 1937 to one-third of their 1932 level, hundreds of brilliant scientists exiled or imprisoned, others—like Lennard, the physicist—reduced to tub-thumping inanities, paraphrasing for a pseudo-scientific world the political doctrines of the Führer.

Science as we know it is abhorrent to the Nazis. Instead they will permit such "science" as helps them to world domination or supports their political creed:

"What is the purpose of University education? It is not objective science, which was formerly the purpose of University training, but the heroic science of the soldier, the militant and fighting science"—(Krieck, Rector of Frankfurt University).

"To-day the German university professor must ask himself one question: Does my scientific work serve the welfare of National Socialism?"—(Frank, Minister of Justice).

Fascism can use the more technical side of science for war purposes, but it cannot abide the search for truth, since Fascism is based on a lie. Hence the characterization of all theory as "non-Nordic" and the assertion that true German science is empirical only—for experiment may provide war weapons or *ersatz* materials, but the correlation of experiments by theory is the sure way to the exposure of the lies upon which Fascism is founded. And even if the theoretical work should happen to be concerned with relativity or the quantum theory, it is still dangerous to Fascism, for it may lead only too easily to scientific thinking in other fields—such as sociology.

One form of theory, of course, Fascism can stand—any distortion of the truth which may help in its politics of enslavement. Thus the Darwinian survival of the fittest is twisted and distorted on a nationalistic basis to provide a justification for war. Thus a racial theory bearing no relation to the findings of science is invented to justify and to encourage the Nazi ideal of world domination, by showing that other peoples are only half-way between men (i.e., "Nordics") and apes. The following passages are not the work of some cheap tub-thumper. They were written by *Professor* Herman Gauch in a work entitled *New Bases of Racial Research*.

"In non-Nordics, the teeth, corresponding to the snout-like narrowness of the upper jaw, stand at a more oblique angle than in animals. The grinding motion of chewing in Nordics allows mastication to take place with the mouth closed, whereas men of other races are inclined to make the same smacking noise as animals . . .

"The Nordic mouth has further superiorities. Just as the colour red has a stirring effect, the bright red mouth of Nordics attracts and provokes kisses and courtship. The Nordic mouth is kiss-capable. On the other hand, the non-Nordic's broad, thick-lipped mouth, together

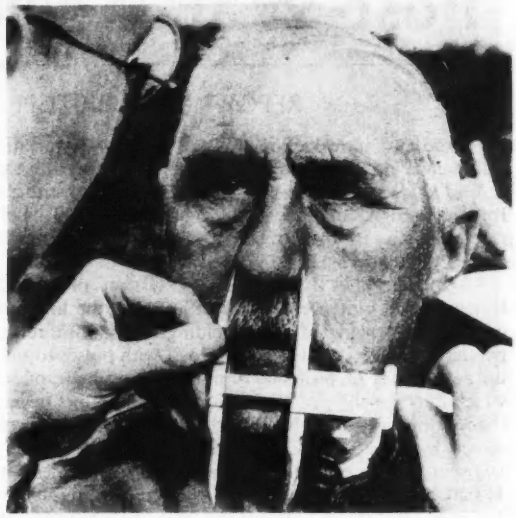


FIG. 7.—Nazi Racial Theory in Practice.

This unfortunate man is having the breadth of his nose measured to determine whether he is a Jew or not.

with his wide-dilated nostrils displays sensual eagerness, a false and malicious sneering expression and a dipping movement indicative of voluptuous self-indulgence . . .

"Generally speaking, the Nordic races alone can emit sounds of untroubled clearness, whereas among non-Nordics the pronunciation is impure, the individual sounds are more confused and like the noises made by animals, such as barking, sniffing, snoring, squeaking . . .

"If non-Nordics are more closely allied to monkeys and apes than to Nordics, why is it possible for them to mate with Nordics and not with apes? The answer is this: it has not been proved that non-Nordics cannot mate with apes."

Where does "Nordic empirical science" stand in relation to these mouthings? Is there anything to choose between this (which is no isolated quotation) and the theories which the orthodox strove to maintain against scientific advance in the sixteenth and seventeenth centuries? The reader may have found it difficult to believe some of the assertions made above about the relations between scientific and political freedom in that earlier period. Perhaps, if he will contemplate the treatment of science under Fascism to-day, he may find them more credible.

Copernicus and Vesalius struck the first blow in the battle for the freedom of science four hundred years ago. But to-day that battle is renewed. Either science or Fascism must perish. And the scientists of this country have no small part to play in deciding which.

Post-War Agriculture in Europe

REPORT ON BRITISH ASSOCIATION CONFERENCE

AN excellent introduction to the British Association Conference on Co-operative Systems in European Agriculture held on April 16 and 17 at the Royal Institute of International Affairs was provided by Sir John Russell's recent lecture to the Royal Institution on "Restarting Agriculture in devastated Europe".

After the Allies have taken possession of territory formerly held by the enemy, said Sir John, the first stage must be the sowing of crops yielding high caloric returns per acre, namely cereals and potatoes, with pulses to make up deficiencies of protein. A minimum estimate of seed which must be shipped to the Continent amounts to more than a million tons. More difficult problems were presented by livestock, for it appears that by the middle of last year the loss of cattle alone was probably not less than 11,000,000 head—a quarter of the pre-war population. In Greece and Poland for instance the numbers were down by about a third or a half. The fall in milk yield has been estimated at 35%. Losses of sheep and pigs have been at least as great, if not greater. Restoration of the animal population would be slow; to achieve it would take 5 to 8 years for cattle, 5 to 9 years for sheep, 1 to 2 years for pigs and poultry, and up to 16 years for horses. Transport difficulties made it apparent that the establishment of herds of milking cattle must come mainly from natural increase. Fortunately, artificial insemination enabled good bulls to be used very economically; the bulls could be kept at control stations and the semen distributed by motor-car or aeroplane over a large number of farms. Pigs and poultry unfortunately were most like humans in their food requirements, and when human food is scarce pigs and poultry are not to be encouraged.

After dealing with the "first aid" stage of post-war agriculture on the continent Sir John considered whether Europe should adopt a policy of self-sufficiency or a high standard of nutrition. He said that the representatives of the occupied countries now in this country rejected the former idea, but the attainment of the second policy meant that each region must produce the foods it can grow best and exchange its products freely with other regions; there is no place for restrictions on trade in food. The farmers of Europe would have to aim at producing high-quality protein and protective foods and they would import from the great primary producing regions of the world the additional calories and protein needed for themselves and their animals. He concluded by expressing the opinion that peasant farming was the economic ideal for Europe and he elaborated this theme in the first session of the British Association conference.

He told the British Association that all the evidence showed that Europe would prefer peasant proprietorship to large farms after the war, but no solution of peasant problems could be satisfactory unless the problem of money-lending, one of the greatest of the peasant's life, was adequately dealt with. "Co-operation offers the best solution we know at present," he continued, "Co-operation however, will not develop unaided. It wants care and attention and the middlemen and money-lenders who are astute to realize its dangers for them are always ready to take advantage of any possibility of killing the movement. We hope as the result of preparations now being made that the Government of each country will be able to say to its peasants as it enters to take charge after the expulsion of the enemy 'Here is your land; here are seeds and implements; get on with your job of producing food for our hungry people—and from the start begin to co-operate. It will give you a better return for your labour. It will give the country richer harvests from its lands.'"

The problem of eliminating starvation from Europe was clearly stated by a Polish representative, M. J. Kwapinski, who gave figures of the calorific value of food now available in Poland. He said that the energy in the food distributed to the Polish Christian population in Warsaw amounts only to 600-800 calories daily (the League of Nations standard is 2,887 calories) while for the Jewish population the calories are 220-290 daily. In the first aid period the most important problem would be *the speed of supplying the most necessary foodstuffs*, and air transport would have to be used for supplying foodstuffs which therefore must take up the least space and weight—and must be, in large measure, dehydrated.

Speakers from many Allied nations gave details of the way in which co-operative systems of agriculture operated in their own countries. The account given by the agricultural attaché to the Danish Legation, P. A. Moltesen, of conditions in his country illustrates the typical mechanism of co-operative farming enterprise. In the co-operative creameries of Denmark for example each member agrees to deliver his total milk production, excluding his own requirements to the creamery for a certain number of years. These creameries receive the milk and produce butter and cheese. The co-operative bacon factories were on an even larger scale. Danish farmers have a special co-operative society for seeds. Cattle breeding societies and milk recording societies were also based on co-operative principles and so were the recently-formed societies for artificial insemination.

The figures given by the French delegate, André Dulin, were of special interest emphasizing as they did the essentially peasant structure of French farming in particular and European farming in general. Out of 4,000,000 French farms nearly 3,000,000 are of less than 20 acres, and only 1,743 of 1000 acres and over. With the numbers for farms of intermediate acreages his figures composed a characteristic "pyramid of numbers".

N. Barou, speaking on Soviet agriculture, made the point that the system of machine-tractor stations under State control, as introduced in Russia, could be widely applied in Eastern Europe. He also stressed the fact that collective farming makes easier the wide application of science to agriculture and the scientific training of the farming community.

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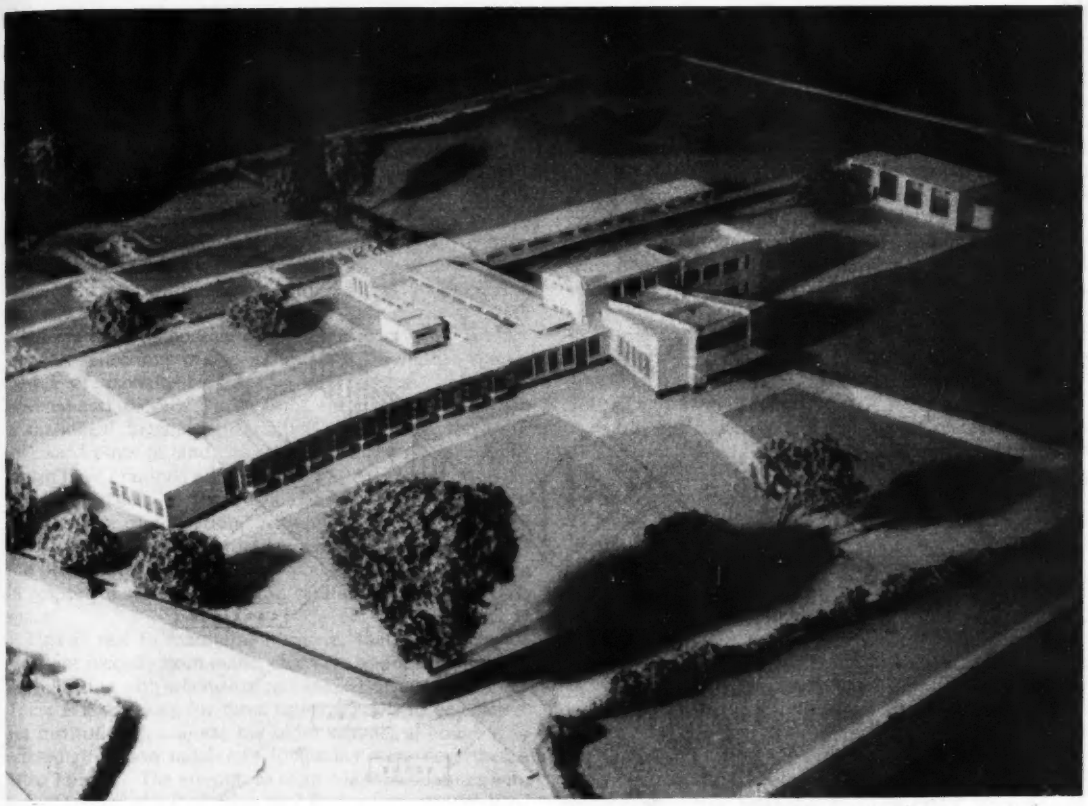


Courtesy of the Cambridgeshire Education Committee

FIG. 1.—The future standard of a rural school and its environment.

School Architecture—Function and Design

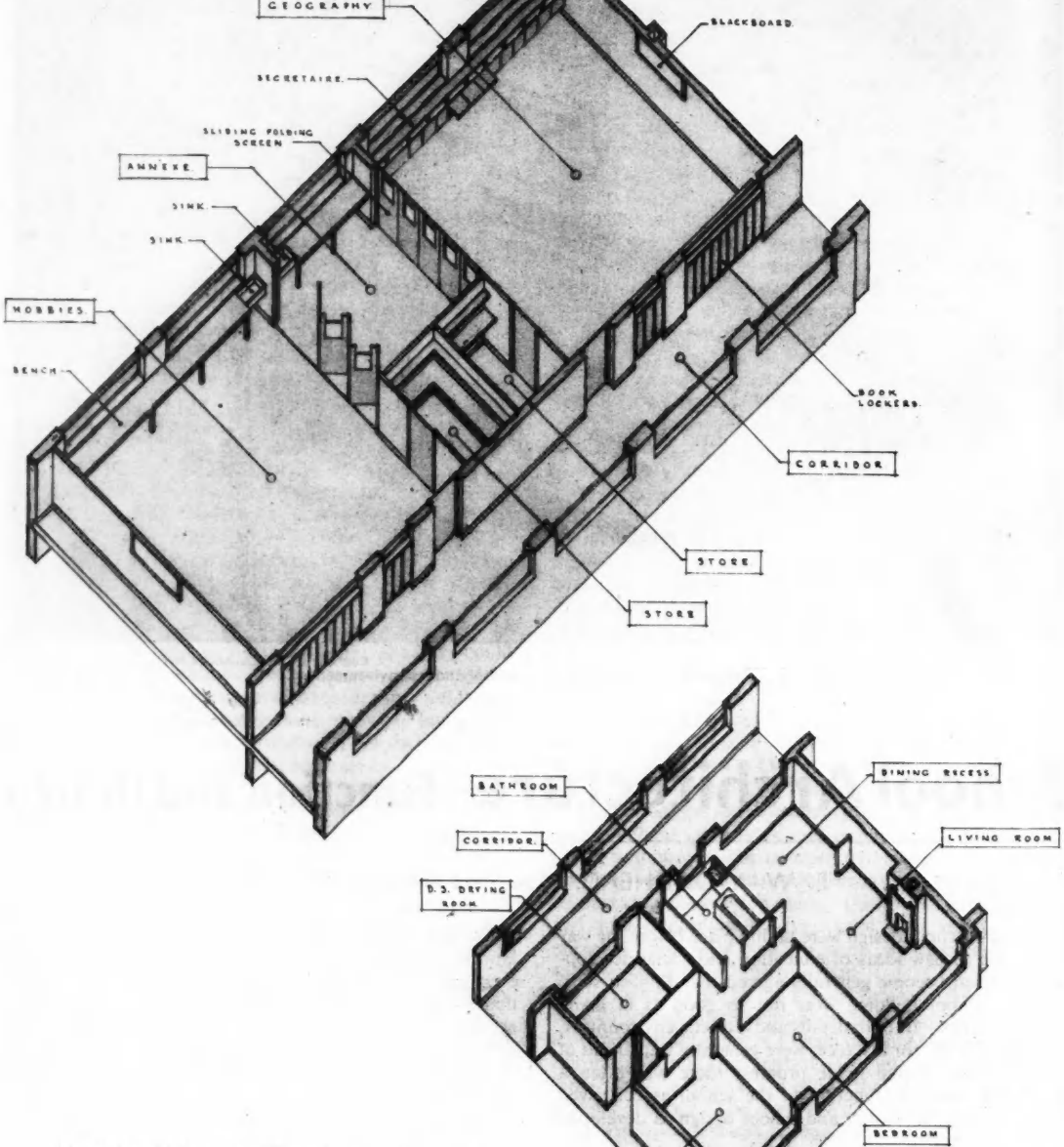
E. W. WOODHEAD, M.A., and H. ALSOP, M.A.

CHANGES in school design were taking place before the war in relation to new ideas of education and social development. It had become generally agreed that English standards in school building were not so good as in many other countries. In both details and æsthetic environment, German schools, for instance, were generally well ahead of ours. Where we had made progress there was often a divorce between the function of the school as conceived by the educational expert and school design as developed by the architect.

For our schools the Board of Education Code of 1926 sets out minimum standards and, modest as these are, they are by no means universally attained. Summarized briefly, they stipulate that schools should be convenient and healthy, adequately lighted, heated, ventilated and cleaned; they should be suitably arranged and furnished for instruction; they should not exceed, in school population, the recognized accommodation; and should offer reasonable facilities for medical inspection. Such regulations, with their indefinite standards, permit, one might even say invite, variety of interpretation, with the result that even new schools have failed to realize the standards appropriate to the importance now being accorded to the education service. It is a lamentable commentary on the conception of the place of education in the community that of all its public buildings the school should be among the least attractive and inspiring.

Criticism of Existing Provision

Most present-day schools, and especially those for elementary education, faithfully reflect a social outlook on the place of education in the community which we are beginning to outgrow and which we are promised is to give place to a more liberal and personal conception. These schools have failed to provide the opportunities for



Courtesy of C. L. Lister, A.R.I.B.A.

FIG. 2.—Rooms planned for flexibility and approach.

efficiency in the staff and progress in the children which have, for a long time, been possible through advances in science. Despite technical progress, heating and lighting systems are far from satisfactory. Methods of cleaning fall short of those in decently-run homes and make the prescribed health instruction a pathetic hypocrisy.

From the æsthetic point of view, most of our schools are lacking in appeal and inspiration, this being true not only of the drab buildings or those unfunctionally ornate, but also of the individual rooms with sombre-coloured walls and woodwork, dark-coloured heavy desks, the absence of tasteful pictures, a general preference for high windows and for opaque glass. The sites, too, are often implicit reflections of the nation's apathy, either wildernesses of asphalt, bleak, grey and treeless, or gravel-covered and uneven. There seems, moreover, to have been a diabolical ingenuity in finding for schools the most awkward plots of land, from their nature imposing limits which have cramped all attempts at adequate development of most aspects of the curriculum and particularly the physical side of education. Although this picture of most town schools is not overdrawn, even country schools are too often little better, on most scores, and are often worse in respect of water supply and sanitation, and classroom space.

This is not to maintain, however, that improvements have not recently been made, chiefly in senior schools built in connexion with schemes of reorganization and rehousing. There is a tendency for these newer schools to be efficient yet institutional, whereas the older schools, although they offered provision indifferent in quality were nevertheless often homely. The attempt to reconcile these features with the modern methods of using steel framework, standardized parts, and pre-fabricated units, presents a problem both to the educationist and to the architect.

Needs of the Children

The Report of the Board of Education Consultative Committee on the Primary School (1931) declared that "the curriculum is to be thought of in terms of activity and experience, rather than of knowledge to be acquired and facts to be stored", thus envisaging a type of education for which few facilities are offered by most older buildings. The conception of the function of a school has thus become more closely related to the art of living, as distinct from mere instruction, and this outlook is an indication of a social change in our way of regarding the needs—physical, mental and spiritual—of our children.

These needs, in relation to the welfare of society, must determine what a school building is to be like. If our diminishing child population is to be efficient, the schools must be so designed as to meet not only the new curriculum but also to cater for health and nutrition. There must, for example, be considerable thought given to the provision of facilities for the reception, preparation and distribution of food and its provision in a social atmosphere.

This is a matter which we can afford to do in one way only—adequately; and this entails provision so rarely found as to be equivalent to a revolution. It means ample room space for the reception of the milk, with easily cleaned floor and large and deep sinks for warming the milk; and if we develop beyond the consumption of milk from the bottles, it demands a supply of mugs, adequate and proper storage for them and drying space for towels, and, if the health of the children is to be safeguarded, plant for sterilizing. Another need so often overlooked is the provision of well-designed trolleys for the distribution of the milk; and its consumption under proper conditions of social training involves the provision of table-cloths or table mats, and the contingent laundering.

The new standards of personal cleanliness which are extending upwards from the nursery-infant school should find facilities in all schools for their practice. What has been done for miners in recently built pit-head baths in providing for cleanliness and the drying and disinfecting of clothing is no less necessary for children and adolescents. Along with this provision there would again be need for adequate laundry facilities.

Another need of the child is that of recreation, within and outside school hours. The usual equipment of a good children's park is necessary for the younger children, and for the older there must be areas for both national games and minor team games, and also swimming baths.

In meeting in this way the needs of the children, we shall be working on the sound assumption that the nation can only be as good as the sum of its individual citizens. So long as children live their school life in a school lacking the amenities of a good home and its standards of furnishing, decoration, pictures and adequate space, so long will it be absurd to expect those children to make full contribution to the maintenance and betterment of the society of which they become part. Citizenship is learned in the process of living together and for this purpose schools must offer the children rooms where they can play together, work together constructively, make music together, eat together sociably, pursue hobbies and crafts together, hold club-meetings. In rural schools the care of pets and accommodation for young farmers' clubs will afford similar opportunities. And if what is thus beginning to be learned by the leaving age in this art of living is not to be lost almost entirely in the post-school years, and especially until the majority of homes can offer the stimulation needed, the schools must be planned to meet their needs as adolescents and even as adults.

If the interests aroused in the new schools are to continue into adult-hood and if the schools are to be centres of community living, there must be appropriate adult wings and the whole provision must be reviewed from the point of view of use by youth, by day continuation schools, and by groups within the local community association.

Relations Between Functions and Planning

This relationship must be reflected in the provision made. In particular the Junior School must have its practical rooms, and since the aim is to bring children into more and more fruitful contact with their environment, there must be adequate storage for all kinds of materials. Nor should this be, at any rate of necessity, on the old basis of cupboards, but rather of the store-room off the practical room, with plenty of shelfing, cupboard space deep as well as narrow, and preferably sliding doors both to store and cupboards.

This problem of storage affects also the Infant and the Senior Schools. It must be understood that the sensory

For both these crude attempts at solving the problem there apparatus used so freely in Infant Schools demands deep storage, and cupboards (needed in this case since they should be accessible to the children) must be deep and of height suited to infants. This may appear a small matter, but it is a real example of the need of planning being related to function. And the same is true of extensions of practical space in connexion with History and Geography and Hobbies rooms, where an annexe of about a quarter the size of the room, say, balancing the store already referred to, should be provided with a deep sink and draining board, a drop-table, a light bench, and some book-shelves. Both Junior and Senior Schools must also have a library room, and this should be furnished with a good type of table and chair and also with a magazine rack.

In no part of the curriculum has a greater advance been made than in science. Provision for specialized branches of science continues to develop in secondary and technical schools. But in the junior forms of these schools and in senior schools everyday science is being encouraged and is emphasizing two aspects of science which require appropriate accommodation and equipment. Biology is coming to be regarded as the most fruitful science for these schools, and if it is to be taught realistically and not merely from books, which is entirely the wrong approach, the Science room must have the right facilities. These must comprise a long wall bench with deep sinks, a shelf above for growing specimens, and another side shelf for tanks, pet cages, etc. If these latter can be seen through the corridor windows, they prove an endless source of information and stimulation.

The other kind of Science appropriate to these schools is again founded on the practical approach, and since its purpose is to reveal the scientific principles embodied in the common mechanisms of daily life (the bicycle, petrol engine, wireless set, magneto, clutch, vacuum cleaner, gas and electricity meter and so on), the room must obviously afford ample bench space and storage room. There will need to be also distributed current points ranging from alternating current of the standard voltage to quite low voltages via a transformer, which should itself be located safely out of reach. Such Science rooms must at long last be regarded as workshops, with an entirely different equipment and lay out from that of the academic physics and chemistry laboratories.

Moreover, the increasing use of visual and auditory aids such as the epidiascope, the projector and the wireless set necessitates much careful planning; not only is it necessary to arrange for accessible lighting and wireless points, the latter allowing for extensions to neighbouring rooms, but the location of screens; and the problem of acoustics is to-day more than ever in need of solution now that not only halls but classrooms also are used for sound films and for wireless. The specialized information on this problem as well as on that of lighting standards is all too often completely ignored, with lamentable effects of strain on both pupils and teaching staff.

Another problem, that of the right storage of the child's own books and materials, has still to be considered. In Infant Schools these are too often kept in bags which festoon the backs of chairs, and in Junior Schools and most Senior Schools they are kept in locker desks which are a cumbrous and heavy type of furniture, making rearrangement of a room to meet changing needs almost impossible. should be substituted batteries of lockers let into the wall of the room and opening both into room and corridor. The furniture can then be lighter in construction and of stackable type lending itself to the new conception of education as an activity. This raises a new problem, that of the ink-well, which can, however, be solved by the use of what may be called "secretaires" or wall-fixed drop-type writing tables not normally obtruding into the room.

Saving of Time and Cost

There is a tendency in the modern planning of schools to provide an open plan with an extensive site, and this may be combined with the use of standardized construction. The object here is to save time and cost; but it is worth reminding ourselves that cost and speed of construction will depend on how far certain features common to the needs of types of school can be standardized. In this category are such equipment as storage for gymnastic clothing, forges and flues, timber storage, windows, heating apparatus, flooring, stage equipment—to mention only a few examples. To oppose such reasonable standardization is to ignore the valuable advance made by this means in the quality and cost of the products of the Associated Builders' Merchants and similar providers of daily necessities in home and office; but it is true that such standardization should be done by experts who have been carefully chosen because of their understanding of the needs which they are trying to meet. At present reliance is often placed on the recommendation of an individual firm, instead of a decision being reached on the authority of an impartial source of information.

Standardization, however, involves the risk that schools may become too institutional in character, and therefore, more likely to repress than to stimulate. In the attempt to secure speed of construction and reasonable cost, the need for individuality and homely features must not be overlooked. But this again raises the problem as to what safeguards are needed against the haphazard introduction of features which would defeat the æsthetic integrity of the school thus planned. The stage at which the users of the school are to be given any choice and the extent of the choice allowed must be decided. The difficulty may be met perhaps by settling in advance a range of colours and types for pottery and curtains and a selection of pictures and frames, so that whatever the choice made there could result no damage to the harmony of the total conception.

The value of standardization to meet as rapidly as possible a present need must not blind us to the fact that there are considerable variations in school population and fluctuations in the respective numbers of Infants, Juniors and Seniors to be catered for. To meet these needs, and to provide for such modifications of curricula as may be part of the post-war reorganization of education, it is obviously important that the question of adaptability should not be overlooked.

Finally, this question of saving time is not confined to the constructional aspect only. The administrative stages which precede the construction are at present too wasteful of time to go unchallenged. If valuable years are not to be lost, the cumbrous process of obtaining consents, involving not only the Local Authority at the one end, but also more than one central department at the other, must be simplified.

The Bookshelf

Modern Synthetic Rubbers. By HARRY BARRON, Ph.D., B.Sc. (Chapman and Hall, Ltd., pp. i-viii+274+76 plates, 25*s*. net.)

THE author has performed a valuable service to organic chemists in general, and those directly concerned with the rubber industry in particular, by assembling in compact form the mass of new knowledge that has accumulated during the last quarter of a century in the search for substitutes for natural rubber.

In spite of the immense labour which the author has devoted to his task of assembling and expounding the new facts about artificial elastic materials, there is in the book a number of annoying examples of what would seem to be carelessness.

These may be due to the stress and strain under which the book was written (cp. author's preface), but the writer's avowed realisation that "errors and omissions" might occur inevitably raises the question as to why he did not enlist the help of a friendly critic to read his manuscript.

Such external aid would, without doubt, have helped to eliminate also a number of clumsily constructed paragraphs in the work. For example, the opening paragraph of Chapter 4 which says: The academic background of synthetic rubbers is similar in many respects to that of raw rubber . . ." is not very enlightening, and whatever is implied should be re-stated in more intelligible form in a second edition.

It is a grave lapse for the author to have confused the discoverer of Mauve (in 1856) with his son Professor W. H. Perkin, who was engaged in blazing the trail for synthetic rubber in 1910-15.

In the early part of the section on Raw Materials (Chapter 6) the author should have made it plain that one of the raw materials considered by the Perkin group was *n*-butyl alcohol made by the fermentation of maize starch by *Bacillus butylicus*. This phase in the history of synthetic rubber is dealt with in a contribution of Perkin's (*J. Soc. Chem. Ind.*, 1912, **31**, 618) which does not appear in the list of references.

The ideas in the opening paragraph on "The Production of Synthetic Rubber Raw Materials" (p. 87) need a clearer statement to make them intelligible.

The chapters on the technique of Polymerisation, Co-polymerisation, and Emulsion Polymerisation are excellent and full of valuable information gathered from the widely scattered sources.

A statement on p. 153 that "Perbunan is considered to have a cyclised molecule" seems risky. The vague evidence for this view in the one sentence referring to it is far from convincing.

Chapters 11, 12, 13, 14 and 15 embracing the technology of Perbunan, Hycar, Chemigum, Neoprene, Poly*iso*butylene and Thioplasts (the rubber-like materials made by interaction of alkali polysulphides with dihalogenated aliphatic compounds, e.g. ethylene chloride) contain a mass of detailed information of very great value to those who have not access to the extensive technical literature on rubber.

It has needed courage to write a book on a rapidly developing subject like this, and high credit must be given to the author for providing such a valuable running commentary. E. HOPE.

Wings of War: An Air Force Anthology, edited by F. ALAN WALBANK, with a Foreword by the Rt. Hon. Sir Archibald Sinclair. (Batsford, London. pp. viii + 164, and 52 photographs. 12*s*. 6*d*.)

THE twin marvels of the modern fighter or the bomber are the scientific training of aircrews and the application of scientific principles in the construction of their machines.

This book concerns the human relationship to the aeroplane, from its early stages until the Battle of Britain, mainly as set down by men and women who have struggled equally successfully with pen or joystick.

The Editor—whose reading of non-technical literature of the aeroplane seems as limitless as the starry heavens—traces the growth of wings from the end of the nineteenth century. The indecision then current of the method of approach to flight by man is apparent from the extracts from writers of that period. The bat-like embryo planes and the first regular Army balloons—museum pieces to the young flyers of to-day—spread their wings and reminiscently rise through the word pictures and real photographs by many of the early airmen.

Then comes the first world war—before the new aerial weapon was ready for the task that conditioned it to become the world's lethal instrument No. 1. The story of those hectic four years, when scientists and technicians literally competed against time, to change a rickety, uncertain structure into a tried and sound machine is fascinating. This change is indicated in even the descriptive literature of that period. Into the common language of this country new words and phrases gradually creep. Technical jargon, rating figures, and so on appear more frequently.

After the war, and during the two decades of nigh-peace that followed, the great transoceanic-transcontinental races to prove the endurance of flyer and machine focused attention upon aerial development. The days of Columbus were re-enacted in the air, although the prizes were far less. British, American, Italian, German, Japanese strived to outhop the other by glorious deeds of endurance. Rivalry was fierce, yet withal an air-comradeship among the flyers was growing which is kindred to that of men of the sea. Improved construction and technique went hand in hand. The all-metal plane was evolved to give yet added support to airmen's soaring ambitions. The popular baby plane was within sight with the cessation of peace.

Arming and armouring the aeroplane were once more to be the prime consideration of designers. Thousands upon thousands of men were to taste the exhilaration of flight. Many more airmen-authors were to hand for Mr. Walbank's avid eye to light upon. His task of selection was now more difficult, but he met it valiantly.

The more discerning readers of *Wings of War* may perhaps raise an occasional eyebrow at the omission of some particular author, but all will agree that this book is an amazing running-commentary—in both prose and poetry—upon the birth and growth of one of the finest air forces that the world has yet seen, but which, alas, circumstances since its conception have contrived to prostitute. P.V.D

The Revolving Heavens. Astronomy for Observers with the Naked Eye. By REGINALD L. WATERFIELD. (Gerald Duckworth and Co., Ltd., London), 1942, pp. 206; 29 figures, 8*s*. 6*d*. net.

THE author of this work is a well-known amateur astronomer, though his work in the astronomical world should entitle him to be ranked as a "professional" astronomer. He was Director of the Mars Section of the British Astronomical Association, has organized and carried out expeditions to five solar eclipses, possesses a very fine photographic equipment for the study of star fields and comets, is the author of an excellent work, *A Hundred Years of Astronomy*, and was the recipient of the Jackson-Guilt medal at the Royal Astronomical Society, April 1942. At present he is in H.M. Forces—in the Army Medical Service.

We should expect that anything emanating from one who is devoted to astronomy for the pure love of the science would be dealt with in a comprehensive and masterly manner, and readers will not be disappointed. There is an increasing interest in observational astronomy at present, largely a result of the black-out which renders naked-eye work very much easier for town dwellers. The book is intended primarily for those who have little or no instrumental equipment and includes 29 figures to illustrate the various phenomena of the heavenly bodies which are described. A large part of the work is devoted to the solar system—the sun, moon, planets, comets and meteors, and Chapter X deals with a few of the more prominent constellations and stars, including double stars, variable stars, star clusters, gaseous and spiral nebulae, etc. Some readers may think that the explanations of the motions of some of the planets relative to the earth in Chapter VIII and IX are unnecessarily prolonged, but the author has considered those who are not conversant with the most elementary principles of planetary motion, and the chapters provide very adequate descriptions for them.

We have noticed a few slips, all of minor importance, which do not detract from the value of the book. M.D.

Far and Near

Retirement of Cambridge Vitamin Expert

SIR FREDERICK GOWLAND HOPKINS, Nobel prizewinner for his work on vitamins, retires in September from the William Dunn chair of biochemistry at Cambridge, which he has occupied since 1921. His association with Cambridge University began in 1898 when he was invited to plan a curriculum for instruction in physiological chemistry. In 1914 a special chair of biochemistry was instituted for him at the University, where he has remained ever since. His experiments on vitamins began in 1906, and in that year he declared that no member of the animal kingdom could live solely on protein, fat, carbohydrates and salts, and that the absence of vitamins (which he called "accessory factors") led to deficiency diseases such as scurvy. His work in this field proved the starting point of modern vitamin research which has made possible the abolition of diseases such as scurvy and rickets in civilized countries. Sir Frederick will be 82 in June.

Research and the Farmer

THE time-lag between the discovery of new techniques and their application is nowhere greater than in agriculture, and the first report of the Agricultural Improvement Council (*Agricultural Improvement Council for England and Wales—First Report*—H.M.S.O. 3*d*.) gives some reasons why this should be so. The report points out that if new scientific methods of farming are to be widely brought into operation some measure of economic stability in the industry is necessary. In England and Wales there are about 300,000 farmers, horticulturists and smallholders.

Of these some 200,000 are farming less than 100 acres, and the great majority have not had a high standard of general or scientific education, and most of them have little capital. For many years before the war large sums were spent on research, education and various projects for improving the standard of British agriculture which hardly met with the success they deserved. "This disappointing result was largely due to the fact that agriculture was passing through a prolonged period of economic depression," the report comments. The committee considers that for the majority of farmers the first requisite is a better general and scientific education and the establishment of systems of farming based on sound agricultural principles and practices formulated in the light of modern scientific knowledge. In applying new scientific knowledge to farming practice one of the essential needs is that local advisory work should be done by men who are practical agriculturists. The Council believes that successful progressive farmers are of the utmost value in promoting the general adoption of new ideas, for the average farmer will not readily accept as satisfactory evidence the farm accounts of farms financed and run from public funds. Still less will he accept the descriptions of what has been achieved on farms which he has not seen. Progressive farmers are able to convert their brethren to new methods by showing their economic value in ordinary commercial farming.

Arising from the Council's recommendations practical demonstrations have been held in different parts of the country; for instance, in areas where arable cultivation had become a lost art demonstrations were arranged to show which were the most suitable varieties of cereal to grow on the newly ploughed land. Farmers have been similarly instructed on such matters as the control of pests and diseases, drainage and rotation of crops. It is also noteworthy that recommendations made by the Council with regard to agricultural machinery, re-seeding and ley farming, and hill sheep farming have been adopted by the authorities.

Phosphate Shortage is Farmers' Loss

THE potential loss of farm crops in England and Wales through serious phosphate deficiency at the present time is of the order of £5,000,000 to £10,000,000. Much of the land is not getting phosphate, and if an additional 10% of acreage received phosphate this would result in a gain in crop yields valued at £500,000 to £1,000,000 in a single year. These statements were made by Dr. F. Yates of Rothamsted Experimental Station in a lecture to the Royal Society of Arts on March 24. Among the agricultural surveys he referred to was the Survey of Fertilizer Practice commenced in 1942, which has shown that farmers tend to manure the crops grown on old and new arable land in the same way although the latter are likely to be much more deficient in phosphate, particularly where the soil was wet and acid.

Nature Conservation in Britain

THE Nature Reserves Investigation Committee, which includes such well-known biologists as Dr. J. Ramsbottom and Prof. E. J. Salisbury, has published a report on nature conservation in Great Britain.[1] The committee, set up in response to an official request, suggests that in the more remote parts of Great Britain it might be practicable to provide areas for the preservation of certain mammals and birds on the lines of National Parks which other countries possess. The formation of national forest parks by the Forestry Commission should be encouraged. The hand of the ecologist can be discerned in the recommendation for the establishment of habitat reserves, in which natural assemblages of plants and animals could be preserved, in addition to species reserves, amenity reserves, and educational reserves. The last category, the committee says, should be available for experimental treatment, and educational centres and schools should be encouraged to become responsible for small reserves of their own. The report contains a recommendation that geological exposures of scientific value should be scheduled for preservation in the same way as are monuments of historical or archaeological importance.

[1] *Nature Conservation in Great Britain*, published at 6d. by the Society for the Promotion of Nature Reserves, British Museum (Natural History), London, S.W.7.

Great Authority on Plant Diseases

IN the death of Sir Edwin John Butler on April 4 at the age of 68 the country has lost one of her greatest authorities on fungi and plant diseases. For 15 years he was director of the Imperial Mycological Institute at Kew, and from 1935 to 1941 secretary of the Agricultural Research Council. His reputation as a mycologist was established with the publication of his monograph on *Pythium* in 1907. Two years before that he had been appointed Imperial Mycologist to India, where he had been working as a botanist for four years. He helped to place research into plant diseases on a firm basis, and in 1920 his contributions to Indian agriculture were recognized by his appointment as agricultural adviser to the Government of India. His important book *Fungi and Disease in Plants* was published in 1918. During the last war he and other mycologists pressed for the formation of an Imperial Bureau of Mycology, and it was fitting that he should have been chosen as the first director of this institution when it was set up in 1920.

German Research turned against the Axis

THE American chemical industry is fighting back at the Axis powers with many secret processes based upon the results of German research. The February issue of *Industrial and Engineering Chemistry* gives some details of the way in which German ingenuity is being used to defeat Germany. Patents which have been taken over include those for producing Tetracene (a percussion explosive), BUNA rubber, ATEBRIN (Bayer's substitute for quinine), Carboloy (tungsten steel alloy), and Plexiglas (a transparent plastic used in aeroplanes). The principal American processes for making synthetic toluene, for T.N.T. production and 100-octane aviation petrol, are based upon information obtained from Germany

Lavoisier's Bicentenary

THE great French chemist Lavoisier was born in Paris on August 26, 1743. The bicentenary celebrations will include a lecture by Sir Harold Hartley to the Royal Society on October 14.

Killing Bacteria in Air Raid Shelters

ONE of the most useful disinfectants to emerge from medical practice of the last war was hypochlorite solution. In *The*

Journal of Hygiene (January 1943) Dr. S. W. Challinor of the bacteriology department, Edinburgh University, suggests that the same chemical can be used effectively to disinfect the air in air-raid shelters and army huts. His experiments show that a single spraying of such crowded quarters with a 1% solution of sodium hypochlorite reduces the total number of bacteria in the air by 33% or more.

Seedless Tomatoes

SEEDLESS tomatoes are being produced in experiments conducted at the U.S. Bureau of Plant Industry station, Beltsville, Maryland. The plants are fumigated with the vapour of β-naphthoxyacetic acid at the stage when the first flowers in each successive cluster open. The treatment, which does not affect the vegetative growth of the plant, results in the development of fruits, 50% to 98% of which are seedless and therefore contain a greater amount of flesh. Their vitamin C content is as great as that of normal untreated fruits. An account of the technique is given by J. W. Mitchell and Muriel R. Whitehead in *The Botanical Gazette* (December 1942).

A New Insect Pest

A NEW type of insect pest known as the "sod webworm" is reported by H. W. Thompson of Leeds University in the November number of *The Annals of Applied Biology*. It is a caterpillar named *Crambus hortuellus Hb* which has attacked grassland in Yorkshire, producing an effect rather like a moth-eaten carpet. In America the sod webworms ravage cereal crops and tobacco which have been grown on ploughed-up grassland infested with the pest. They appear to flourish on land with a low pH (alkaline soil) and a low phosphate content. Probably the best remedial measure is to re-establish the affected turf by treating it with artificial fertilizers.

Penicillin has its Own Committee

PENICILLIN, the powerful drug obtained from the blue-green mould *Penicillium notatum*, now has a committee of experts all to itself. This step, announced by Sir Andrew Duncan, Minister of Supply, on April 14, has been taken to secure that everything possible is done to promote the most rapid development of penicillin. In addition to Prof. A. Fleming, who discovered penicillin in 1929, the committee includes Prof. H. W. Florey, Prof. H. Raistrick, Sir Robert Robinson, Dr. C. R. Harington, Dr. A. N. Drury, Dr. V. D. Allison, Prof. I. M. Heilbron, Lieut.-Col. Sir Russell Wilkinson (military medical adviser to the Ministry of Supply) and representatives of firms engaged in producing the drug.

On April 8 the Minister of Health (Mr. Ernest Brown) told the House of Commons he had been informed by the Minister of Supply that owing to the great difficulty of the problems involved this substance is unlikely to be available for general use in the near future even if the results of the committee's investigations are favourable.

J. G. Crowther on Soviet Science

ON April 14 Mr. J. G. Crowther, science officer of the British Council, gave a lecture before the Royal Society of Arts on "Science in Soviet Russia". Much of what he said is to be found, in greater detail, in his book *Soviet Science*, and his most interesting remarks concerned the way in which Soviet scientists are contributing to their country's war effort. The Red Army has successfully resisted the combined attacks of the German, Italian, Hungarian, Finnish and other armies, and this could not have been done, he said, without immense scientific and technical resources. The process of building up these reserves of trained scientists began soon after the Revolution. By September 1918 for instance, Prof. Joffe was collecting promising students from all parts of the Soviet Union. His staff at the Physico Technical Institute at Leningrad then numbered eight; within twelve years the institute had 700 students in its laboratories as weil as 1300 assistants and workmen.

He described the physical hardships which Russian "front line" scientists were having to undergo. He cited one group of research workers who did not leave their laboratory for three weeks, snatching intervals of sleep on their benches, but at the end of the three weeks they were able to send away for testing the large apparatus which they had completed. At Kazan physicists had worked in the open air with their bare hands at temperatures of minus 45°C. The metal of the instruments froze to their skin and tore it off, but not one of these scientists stopped until the work was completed. He stressed the fact that although the plan of the Academy for 1943 is mainly directed to the improvement of war industries and armaments, pure science into the theory of numbers, the dynamics of the atmosphere, and so on will continue.

Sir Stafford Cripps, who presided over the meeting, paid a tribute to Russian science and pleaded for close scientific co-operation between Britain and Russia now and after the war. He said that the scientific *liaison* with the Soviet Union was one of the potent forces towards international understanding. He believed that science was one of the many subjects on which we could learn from the Soviet Union and he hoped that we should always keep our minds open to instruction in the development of our scientific life from whatever source it might come—whether from enemy or from friendly countries. He had been amazed like most of the world at the very high degree of scientific backing which the armed forces of Russia had possessed during the war. It was one of those things we very much under-estimated and we were seeing now the results of the long-planned increase of research and development which had been taking place in the Soviet Union. He felt Britain had come to a stage when we had to adapt our ideas and develop some new technique by which the various agencies which were now sharing in scientific work could be better integrated and co-ordinated, and where the State as a whole played a larger part in providing the resources essential to the high technical education which would be required in great volume.

Newton's Library for the Nation

SIR ISAAC NEWTON'S library has been bought for the nation by the Pilgrim Trust. It was put up for sale in two lots by Henry Sotheran, Ltd., the Piccadilly booksellers. The copy of Barrow's *Euclid*, containing notes in Newton's handwriting and considered to be the copy which Newton used when he was an undergraduate at Trinity College, was offered for £500 and the price asked for the other lot (858 volumes), which included first and second edition copies of the *Principia* bearing Newton's own corrections, was £5,000. According to an inventory now at Somerset House, Newton left a library of 1,896 volumes. The books bought by the Pilgrim Trust is the only portion of the library which has remained undispersed and all of these except Barrow's *Euclid* were discovered in 1928 at Barnsley Park by Col. de Villamil. The *Euclid* was found in 1920 when the property of Thame Park was sold.

Some months ago the Pilgrim Trust bought Woolsthorpe Manor, Newton's birthplace, for the nation.

Chemical War on Houseflies and Clothes Moths

MUCH time and ingenuity has been expended on the problem of getting rid of houseflies, and beside the time-honoured fly-paper insecticides in the form of a spray have been tried. Now a new type of spray has been perfected using a solution of pyrethrin in a solvent, such as freon which is a liquid when compressed at 90 lb. per sq. in. but which becomes a gas when the pressure is released. This spray is stored under pressure in a cylinder. On opening a valve the pressure forces the liquid through a nozzle and on coming into the air the solvent evaporates leaving an exceedingly fine smoke of pyrethrum extract which is lethal to flies. An account of the technique was given in a lecture to the Royal Society of Arts on March 31 by Dr. R. E. Slade. As another example of the chemical attack being waged upon insects he referred to the mothproofing of fabrics. Chemicals which have been found useful for this latter purpose include a mixture of sodium antimony fluoride and chromium fluoride, and sodium fluoantimonate.

Rapid Cure for Scabies

A RAPID single-application cure for scabies has been perfected. Dr. Kenneth Mellanby of the Poolsbrook Treatment Centre, Staveley, has found that of 1,000 patients suffering from scabies who were painted with a 20 per cent emulsion of benzyl benzoate (a compound which dries in 10 minutes) over 99 per cent were cured. It is found that there is no need to disinfect clothing and bedding, and patients were able to put on the same clothes they arrived in and go straight back to work or school.

X-ray Analysis in Industry

SOME important developments in the methods and technique of examining the behaviour of solids by X-ray diffraction methods were announced at the Institute of Physics' Second Conference on X-ray Analysis in Industry, presided over by Sir Lawrence Bragg and held in Cambridge on April 9 and 10 last. The first session was devoted to a discussion on "The Quantitative Treatment of Powder Photographs" the introductory papers being "The Cylindrical Specimen" by Dr. A. J. Bradley, "The Flat Specimen" by Dr. G. W. Brindley, and "Microphotometers" by Prof. J. M. Robertson. The second session opened with a brief discussion on a proposal to change the present values used for X-ray wavelengths to absolute values. This was followed by a discussion on "Some recent developments in X-ray diffraction". Dr. A. H. Jay spoke on "Superlattice formation", Dr. K. Lonsdale on "Thermal effects and allied phenomena" and Dr. H. Lipson on "Side-band formation". Dr. A. J. C. Wilson closed the session by giving an interim report on the very satisfactory progress that had been made in the preparation of the Index to X-ray Diffraction Photographs of Powders, the preparation of which had been proposed at the first Conference. The last session was devoted to a discussion on "Line Broadening". Dr. F. W. Jones opened it with a paper on "Quantitative treatment of crystal-size measurement", and was followed by Dr. A. J. C. Wilson, who spoke on "The effects of distortion and other imperfections".

Mr. C. W. Bunn, of Imperial Chemical Industries, Ltd., gave a most stimulating evening address with the title "Towards atomic photography" which he illustrated with many beautiful slides. He spoke of some of the work which has been proceeding in the Cavendish Laboratory and of his own contributions to the development of new techniques.

Agricultural Research during the War

Agricultural Research in Great Britain (H.M.S.O., 1*s.* 6*d.*), is a rather unusual report in that it provides a survey in summary of the agricultural research at present proceeding at centres all over the country. It is best described as a guide book, but it should serve a useful purpose in putting research units which are working on the same or similar problems into touch with each other and so help to eliminate the duplication of research, a phenomenon which scientists are the first to admit is all too common.

It is not a book for the general reader, but it contains some interesting and novel points. Vernalization, the chilling of seed before planting, is being investigated as a means of advancing the fruiting stage of plants; at the Imperial College of Science, for instance, it has been found that tomato seed can be vernalized by keeping the moist seeds at a temperature of 0° to 10°C. before sowing, with the result that the crop can be increased by as much as 30% during the first few weeks of fruiting. In view of the fact that green tomatoes are unbeneficial to the market, this discovery should find immediate application.

Treatment with the drug colchicine is yielding new plant varieties, and the geneticists of Cambridge and other centres have been able to produce tetraploid varieties (i.e. varieties having twice the normal number of chromosomes) of barley, flax, radish, sainfoin, medick and species of the cabbage genus. Researches are being made into the growing of oil seed plants in this country, and several strains of linseed and sunflower have been found suitable for our climate and soils. Attempts to grow soya bean in Britain have so far been inconclusive, but tests with this crop are continuing.

In the field of animal husbandry the techniques of artificial insemination and the artificial induction of lactation are being investigated. By means of synthetic oestrogens (sex hormones) virgin heifers have been induced to give yields of milk up to 15 lb. a day. War-time shortage of feeding stuffs has given a stimulus to finding substitute diets. The Cambridge Animal Nutrition Institute, for example, has been investigating "bactoflavin", a by-product consisting of the bacterial bodies produced in the manufacture of acetone and butyl alcohol by the fermentation of cane molasses by *Clostridium saccharo-aceto-butyricum liquefaciens*, with a view to its use as a source of protein and riboflavin for farm animals. Again, the Hannah Dairy Research Institute has been investigating how far urea can be substituted for protein in cattle feeds.

Of no less importance, though of a somewhat more routine nature, are the various war-time agricultural surveys and advisory services. The advisory chemists, for instance, are fulfilling an important function in securing that our limited supplies of artificial fertilizers shall be used to the greatest advantage. In the second year of war 86,000 laboratory analyses of soil samples were made, in addition to many rapid soil tests carried out in the field. These analyses have revealed surprisingly large and widespread deficiencies of phosphate and lime. It is encouraging to note that a sub-committee of the advisory chemists works in close co-operation with the Ministry of Supply fertilizers' section in working out the allocation of artificial manures, county by county and farm by farm. Deficiencies of trace elements such as boron and magnesium have been reported. In the case of manganese supplies of the element in the form of manganese sulphate have been set aside this year for distribution by the War Agricultural Executive Committees acting on the counsel of the advisory chemists. Among the valuable surveys being made are the soil survey of the whole of Britain, and the wireworm survey. Up to 1939 about a million acres of soil had been mapped, and the survey is proceeding; its reports will be of immense value to the country in peace as well as war. The entomologists who conduct the wireworm survey have been able to advise farmers as to how to beat this insect pest; they recommend that land with a population of over 600,000 wireworms to the acre should not be planted with crops susceptible to the wireworm. Other special insect surveys cover the carrot fly, cabbage aphis and strawberry aphis. Advice on other plant pests is provided by the experts of the entomological and mycological advisory services.

Infra-red sees through Camouflage

DETAILS about the use of infra-red films for detecting camouflage have just been released by the Eastman Kodak Company of America. The effects of ordinary camouflage can be largely nullified by the use of infra-red film. To the human observer a war-time factory seen from a plane may so well simulate its background, through clever camouflage, that it cannot be picked out, but the infra-red camera reveals with unerring accuracy that something is being concealed. From a military point of view nothing is more dangerous than camouflage which can be detected, for it brings a false sense of security to the military unit or the war factory. The explanation of infra-red detection is quite simple. Natural grass and foliage contain chlorophyll; they therefore appear light, almost white indeed, in the positive infra-red photograph because chlorophyll reflects infra-red light. Greens used in camouflage show up dark, almost black, in infra-red positives, and therefore stand out in striking contrast to real grass and foliage. However, the chemist has recently been able to help the camoufleur out of the difficulty by producing green pigments which reflect infra-red to the same degree as grass. The next move rests with the photographic expert!

Colour Filters and Night Flying

AN ingenious method of giving instruction in night flying has been adopted by the American Navy Air Corps. Instead of using a hood over the cockpit to shut out light, the windscreen and side panels of the cockpit are fitted with a transparent green covering, while the pupil wears dark-red filter glasses. Red and green being complementary colours, the effect is that the airman can see virtually nothing outside although his instruments and controls on the dashboard in front of him are still visible. By changing the dark red filters for light red filters the pilot under training can be given experience of the semi-darkness so often met with in night raids.

T.N.T. Poisoning Loses its Terror

T.N.T. POISONING is a hazard of war-time industry and few would dare to underrate its seriousness. Yet figures given by the Chief Inspector of Factories in April show that the position is rapidly improving due to more ample medical supervision in munition factories and the advances made in the technique of dealing with this type of industrial poisoning. In 1917 there were 44 fatal cases, and 145 non-fatal. Last year only 5 fatal cases were reported out of a total of 26, an improvement on 1941 when there were 41 cases of T.N.T. poisoning and 12 deaths.

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